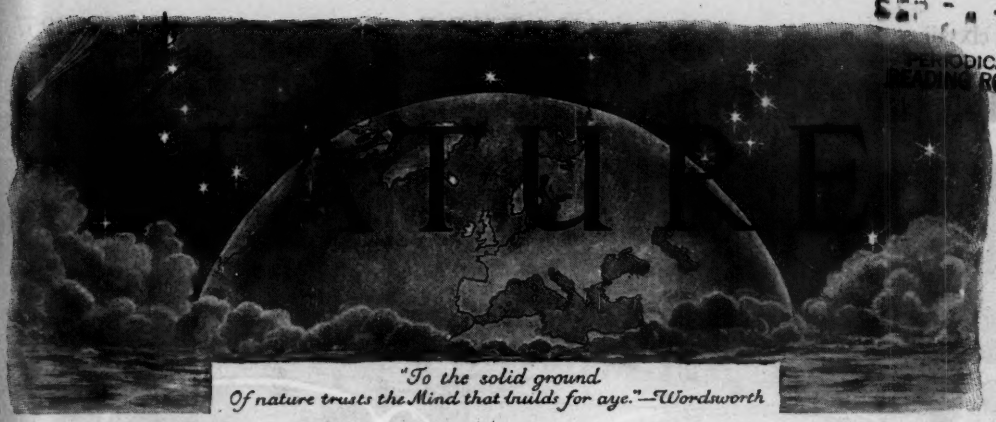
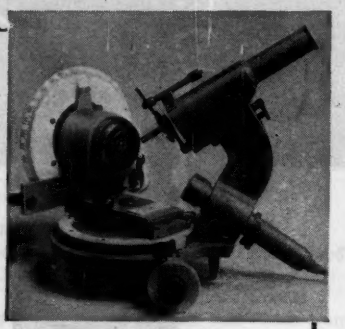
UNIVERSITY OF MICHIGAN
SEP 24 1957
PERIODICAL READING ROOM



VOL. 180, NO. 4581 SATURDAY, AUGUST 17, 1957 2s. 6d.

TECHNE CM. TWO CIRCLE OPTICAL GONIOMETER

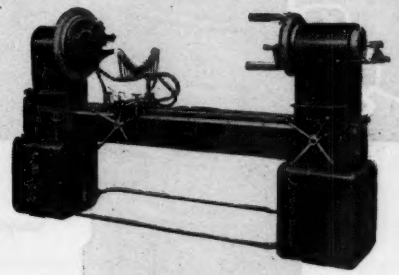
- Robust construction
- Accurate
- Inexpensive
- Novel type quick adjusting head
- Improved optical system
- Crystals rapidly interchanged
- Simple and convenient to use
- Available for 200/250 v. and 100/120 v. supply



TECAM

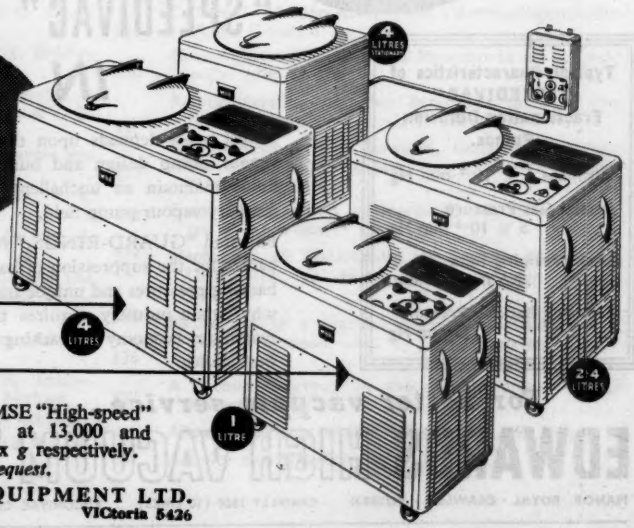
For full details write or telephone.
TECHNE (CAMBRIDGE) LTD.
DUXFORD · CAMBRIDGE
Telephone: Sawston 2246

MODEL IV GLASS WORKING LATHE
36 IN. SWING, 6¼ BORE THROUGH CHUCKS 6 FT. BETWEEN SPINDLE FLANGES. INFINITELY VARIABLE SPEEDS.



May we send you leaflets of our range of lathes?
HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDLESEX
TELEPHONE: UXBRIDGE 6345

MSE
REFRIGERATOR CENTRIFUGES
IN THE 4/6000 SPEED RANGE



Largest capacity . . .
. . . lowest price

In addition to those illustrated there are MSE "High-speed" and "Super-speed" Models operating at 13,000 and 25,000 r.p.m. giving 20,000 and 57,000 x *g* respectively.
Detailed catalogues on request.

MEASURING & SCIENTIFIC EQUIPMENT LTD.
SPENSER STREET, LONDON, S.W.1. VICtoria 5426

Many pumps achieve LOWEST pressures under IDEAL conditions . . .

Typical Characteristics of "SPEEDIVAC" Fractionating Diffusion Pumps.

Ultimate 5×10^{-7} mm Hg

Partial Gas Pressure 5×10^{-8} mm Hg

Backstreaming Rate .005 mg/cm²/min.

Limiting Backing Pressure 7.35 mm Hg

"SPEEDIVAC" pumps achieve them *IN THE FACTORY!*

Whilst a lot depends upon the cleanliness of the system, "SPEEDIVAC" vapour pump design and our exceptional experience of suitable operating fluids maintain an unchallenged leadership in the oil fractionating and mercury vapour pump field.

Patented "GUARD-RINGS," fully-sealed jet caps and vapour quality control baffles for the suppression of backstreaming, ejector-type final stages for high backing pressures and unique fractionating arrangements are only a few reasons why, when industry requires the LOWEST pressures, HIGH speeds and maximum economy in backing pumps and lines, "SPEEDIVAC" pumps are first choice.

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW · TORONTO & MILAN

AGENTS THROUGHOUT THE WORLD

NATURE

No. 4581 SATURDAY, AUGUST 17, 1957 Vol. 180

CONTENTS

Page

Selection of University Entrants . . . 299

Technical Progress in British Industry. By Dr. R. Beeching . . . 301
A New Cosmology. By Dr. S. Raimes . . . 302
High Energy Nuclear Physics. By Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S. . . . 303
Neuropharmacology. By Dr. Marthe Vogt, F.R.S. . . . 304

Supply of Scientists and Technologists for Industry. By Dr. P. F. R. Venables . . . 305
Capital for Scientific Development . . . 307
Smoking and Lung Cancer. By Dr. I. Hieger . . . 308
The National Coal Board's Pneumoconiosis Field Research. By Dr. J. W. J. Fay . . . 309
Nuclear Radiation Measurements during the International Geophysical Year. By Dr. Bert Bolin . . . 311

Obituary :

Lord Clinton, P.C., G.C.V.O. By The Earl of Radnor, K.C.V.O. . . . 312

News and Views . . . 313

Flour and Bread. By Dr. C. R. Jones . . . 317
Institute of Biology Conversazione. By Dr. J. L. Cloudsley-Thompson . . . 319
World Health Organization. By Dr. G. Lapage . . . 320
Instruments for Micro-Meteorological Measurements . . . 321
Rate of Entry of Radioactive Strontium into Plants from Soil. By Dr. R. Scott Russell and G. M. Milbourn . 322
Correlation between Photons, in Coherent Beams of Light, detected by a Coincidence Counting Technique. By R. Q. Twiss, A. G. Little and R. Hanbury Brown . . . 324
Gene Mutations in Human Hæmoglobin : the Chemical Difference between Normal and Sickle Cell Hæmoglobin. By Dr. V. M. Ingram . . . 326
The Repetitive Property of the Human Brain as studied by the Electroencephalogram and the Method of After-Images. By Dr. Catherine Popov . . . 328

Letters to the Editors :

Electrostatic Charges on Spores of Fungi in Air.—Prof. P. H. Gregory, F.R.S. . . . 330
Electron Microscopy of Leaf Surfaces.—D. E. Bradley and B. E. Juniper . . . 330
Distortion of Fluid Drops in the Stokesian Region.—Prof. F. H. Garner, O.B.E., K. B. Mathur and V. G. Jenson . . . 331
Crystal Structures of Silicon Nitride.—D. Hardie and Dr. K. H. Jack . . . 332
Properties of Palladium–Rhodium Alloys.—Dr. F. E. Hoare and J. Preston . . . 334
Attractive Forces between Flat Plates.—Dr. M. J. Sparnaay . . . 334
Oxidation of Pentane in Mixtures with Air and the Negative Temperature Coefficient of Reaction.—R. O. King, S. Sandler and R. Strom . . . 335
Structure of *d*-Urobilin.—Prof. C. H. Gray and Dr. D. C. Nicholson . . . 336
Inhibition of Adrenal 11β-Hydroxylation by Ions.—Dr. Gordon M. Tomkins and Patricia J. Michael . 337
Composition of the Cell Wall of *Lactobacillus bifidus*.—C. S. Cummins, Miss Olivia M. Glendenning and Dr. H. Harris . . . 337
Cell-Wall Amino-Acids and Amino-Sugars.—Dr. M. R. J. Salton . . . 338
Coxo-Subalar Muscle in the Mesothorax of Diptera.—Dr. John Smart . . . 339
Reinterpretation of some Basal Structures in the Insect Ovipositor.—G. G. E. Scudder . . . 340
Development of Beet Eelworm, *Heterodera schachtii* Schmidt, in the Wild Beet, *Beta patellaris*.—Audrey M. Shepherd . . . 341
Diego Blood Group in Negro.—Dr. P. C. Junqueira and P. J. Wishart . . . 341
Mechanism of Contraction of Smooth Muscle by Drugs.—Dr. D. H. L. Evans and Dr. H. O. Schild . . . 341
Mechanism of a Nerve-Impulse Transmission at a Crayfish Synapse.—Dr. E. J. Furshpan and D. D. Potter . . . 342
A Second Oxytocin in the Hypothalamus.—P. A. Robertson and Dr. R. W. Hawker . . . 343
Alloxan Diabetes in the Piglet.—Dr. L. E. Mount . 344
Activity and Specificity of Rennin.—J. C. Fish . 345

NEW

DIFCO

ANTISERA

BACTO-C PROTEIN ANTISERUM
for detection and quantitation of inflammatory diseases.

BACTO-STREPTOCOCCAL ANTISERA
for detection of Streptococci of Groups A B C D F G.

BACTO-E. COLI OB and O ANTISERA
10 SEROTYPES and 2 POLYVALENT
for identification of Enteropathogenic E. Coli Serotypes.

Specify DIFCO *Antisera*

POTENT • SPECIFIC • RELIABLE

BAIRD & TATLOCK (LONDON) LIMITED

SOLE AGENTS FOR GREAT BRITAIN

FRESHWATER ROAD, CHADWELL HEATH, ESSEX

Searching for One Dependable Source for All Your Research Biochemical Needs

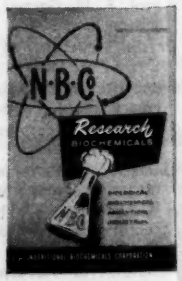
NUTRITIONAL BIOCHEMICALS CORPORATION offers you quality that merits your complete confidence . . . service you can always rely upon . . . plus the economy of lowest possible prices.

A COMPLETE SELECTION OF MORE THAN 165 NUCLEOPROTEINS AND DERIVATIVES

TYPICAL DERIVATIVES

Adenosine Triphosphate	6 Mercaptopurine
Cytidine	Uridylic Acid
Cozymase	Uridine
Coenzyme I, II, A	2, 6 Diamino Purine Sulfate
Cytosine	8 Aza Guanine

Three days after your order is received it will be delivered in most parts of Europe.



NUTRITIONAL BIOCHEMICALS CORPORATION

21010 Miles Avenue • Cleveland 28, Ohio

Write for new Catalog. July 1957. Over 1,700 items. Write Dept. 108.

SELECTION OF UNIVERSITY ENTRANTS

APART from the plans for expansion to meet the growing demand for scientific and technological man-power in Britain to which both the Zuckerman Committee's report on Scientific and Engineering Man-power in Great Britain and the earlier report on the Recruitment of Scientists and Engineers by the Engineering Industry have directed attention, it is now generally realized that the universities are called upon to expand to provide places for the larger number of young people who may be expected to seek entry from 1960 onwards in consequence of the post-war rise in the birth-rate. The current expansion, however, is not being planned solely to meet a temporary situation, but to provide for a permanent increase of about half as many students as the universities are now accommodating. The report on "Early Leaving" suggested that there is a considerable reservoir of talent capable of profiting by a university education, which does not at present reach the universities. It is natural, therefore, that concern should be expressed as to the numbers involved and how far the universities could and should be expected to expand without either lowering their standards or running undue risk of excluding those who were capable of profiting by a university training.

With State expenditure on university education in Britain approaching £40 million a year, apart from expenditure on technological education and large sums for capital expenditure, due care must obviously be taken to see that money is not wasted on those incapable of profiting by further education, as well as to ensure that the best use is made of the money. This involves more than an attempt to see that the disposition of resources between different university departments is in proportion with the needs of the State and the demand for particular types of trained men and women, that full use is made of the facilities provided and that there is no uneconomic and wasteful distribution of facilities between different universities. It is also a matter of finding students with adequate qualifications at entry, and of seeing that standards of teaching are maintained for the larger numbers and not debased either by lowering the staff-student ratio or by lack of equipment and accommodation.

In these conditions the question of how many qualified applicants at present fail to gain admission to a university assumes fresh importance. The lack of places for all the school-leavers who could satisfy minimum requirements and wished to enter a university during the immediate post-war years had led to competition conditions in which school-leavers tended to send applications to several universities in the hope of finding a place at one of them, and this persisted after 1950 even when the expansion of the universities and decrease in the number of ex-Service students had made it possible for the universities to take many more applicants. Increased numbers of State scholarships and local education authority awards had, in the meantime, made a university education possible for many young people who would not otherwise have been able to afford it; but the opinion was widely held that no really worthy applicant was failing to find a place somewhere or other, even if it was not necessarily in the university of his or her first choice.

Nevertheless, from several points of view, it was important to find an answer to the question, if possible, and in January 1952 the Committee of Vice-Chancellors and Principals appointed a sub-committee, with Sir James Mountford as chairman, to inquire into the situation. A report on this inquiry has now been published*, which is of considerable interest in this and in a wider context. The inquiry sought in the first place to provide answers to such questions as: how many applications for entry are received and considered by universities in a single session; how many individual students these applications represent and how they are distributed between the different subjects of study; how many of the applicants are offered and accept places; the reasons some applicants are not offered a place anywhere; and how many places in the various subjects of study are available and how many of them are filled. Although the report is limited to the single year 1955–56—representing accordingly a snapshot of the situation at one particular time—and although its material is not homogeneous and is of variable reliability, it has a wider interest, because the opportunity was taken to collect information about the previous educational background of the applicants, their social antecedents, the sources of their financial support and the careers which, at the time of application, they proposed to pursue. The replies to some of these inquiries are naturally of variable reliability; but none the less, the report throws real light on some important questions, answers to which are desirable if the expansion of university and technological education is to be planned so as to make the best use of available resources.

Between May 1954 and the autumn of 1955 some 70,000 applications, representing 22,000 men and 9,000 women, were received for admission in 1955–56 to full-time university courses in Britain leading to a first degree or diploma; and on an average those with addresses in Great Britain and Northern Ireland applied to more than two places, the number of applications per applicant being highest in the faculties of medicine and science. About 18,000 applicants were known to have been admitted at the beginning of the 1955–56 session, and of the remaining 13,000 less than a quarter were women. Less than 10 per cent of the men admitted

* Report on an Inquiry into Applications for Admission to Universities. By R. K. Kelsall. (Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom.) Pp. vi+32+27 tables. (London: Association of Universities of the British Commonwealth, 1957.) 17s. 6d.; 3 dollars.

came from overseas; but the proportion of overseas applicants admitted was very much higher in dentistry and technology than in other faculties. About two-thirds of the overseas applicants, both admitted and non-admitted, were from countries within the British Commonwealth.

The material relating to the educational background of the applicants is complicated and difficult to summarize, but some points of interest may be noted. Cambridge (34 per cent) and Oxford (42) had the lowest proportion of applicants who had attended local authority primary schools, followed by London (59), The Queen's University of Belfast (68), Scotland (71), other English universities and colleges (74) and the University of Wales (88); but some of these differences reflect, in part, the relative importance of different faculties in the various university groups. There were indeed wide variations in the proportion of local authority primary scholars in the different faculties, the proportion being highest in science (75 per cent) and technology (71 per cent) and lowest in medicine (49 per cent; in Oxford, 20; and in Cambridge, 24). Excluding Oxford and Cambridge, more than 10 per cent of the students from Great Britain applying for admission said that they had been boarders at the last secondary school they had attended; at Oxford and Cambridge the proportion of secondary school boarders among British students admitted exceeded 40 per cent. Among those not admitted, 91 per cent of those proposing to study science were day pupils, compared with 73 per cent for dentistry and veterinary science and 76 per cent for medicine; the corresponding proportions of those not admitted who had been at grammar schools maintained by local education authorities were 75, 54, 60 and 53 per cent, respectively.

These figures certainly suggest that local authority schools are providing a reasonable proportion of those seeking to study science and technology; but this aspect of the inquiry, and also the material relating to the social background, is best considered after dealing with the evidence about the 13,000 who were not admitted, some 2,000 of whom were overseas applicants. About 10 per cent of this total received an unconditional offer of a place either for 1955–56 or for a later session from at least one university. At the other extreme, about 25 per cent of the applicants did not, when their case was last considered, possess the necessary paper qualifications for admission to the course of study they proposed at any university to which they applied. These two groups accounted for about 4,500 of those not admitted anywhere; and although it was difficult to obtain further information about the qualifications of the overseas applicants from further information supplied by the universities, regarding the 6,900 British candidates involved, it seems probable that at least a third of them had all the paper qualifications needed for entry on their proposed course in at least one of the universities to which they applied.

Thus, out of some 11,000 candidates from Britain who were not admitted, about 25 per cent did not possess the necessary paper qualifications, although, in addition to the 10 per cent who were offered places unconditionally in 1955–56 or a later session, at least 21 per cent had all these qualifications. It would seem that the university or college did not in fact always know whether the applicant possessed the minimum paper qualifications when it was not worth while seriously to consider the candidate's suitability because, for example, all places were filled. The universities and colleges participating in the inquiry reported, however, some 2,500 unfilled places at October 1955; but well over half these places were in arts subjects, whereas less than 37 per cent of those not admitted came within these subject groups. Again, some of the unfilled places were due to the failure of applicants for whom they had been reserved to notify the university or college concerned that they were not proposing to fill them, until it was too late to offer the places to others.

Nevertheless, it remains true that a relatively small number of fully qualified applicants, if they had known of the existence of these vacant places in universities and colleges to which they had not applied, might have secured admission there. The number of vacant places may be small and to some extent may be temporarily unavoidable, though a central clearing house for applications might well help to accelerate the filling of last-minute and unexpected vacancies; and the idea might well merit consideration by the universities, if indeed they have not already examined it. It would seem, however, that there is at present a significant number of qualified applicants for whom the universities cannot find room, and the direct approach made in the autumn of 1956 by Sir James Mountford's Committee to a representative sample of British students who were not admitted was designed to throw more light on the problem.

The outstanding result of this further inquiry, which obtained so good a response that the answers can be taken as broadly applicable to the group as a whole, was to show that more than a third of applicants in Great Britain had, within a year of the beginning of the 1955–56 session, been admitted to some institution of university rank. The sample also showed that a further 6 per cent had offers of university places for a session later than 1956–57, usually at Oxford and Cambridge; and it seems, therefore, that we are left with only the 7,000, or 63 per cent of the original total of British students not admitted; and these, according to the information obtained from the universities, either did not possess all the entrance qualifications or their position was doubtful. The sample inquiry provided no firm answer to the question of what proportion of these 7,000 afterwards obtained the necessary qualifications; but it seems possible that between 2,000 and 3,000 people who at least fulfilled the London minimum degree entrance requirements in October 1955 failed to secure admission to any university either then or in 1956–57, or to have a place reserved for them in a later session. Of this 7,000, it would appear that some 1,600 were in full-time attendance at other types of further education institutions, such

as teachers' training colleges, by the autumn of 1956.

The report submits no recommendations, and the Sub-Committee draws no firm conclusions; but the material submitted suggests that the problem is not intractable and should yield to some measure of central organization and co-operation, such as the clearing house for applications already suggested. These measures could well begin if Government support leads the universities to expand in faculties designed to supply the State with the particular categories of practitioners it needs; for although at the moment those not admitted favour science subjects rather than arts subjects, there can be no guarantee that the needs of the State and the aspirations of the would-be university entrant will always run together. The report at least hints at a problem which could become more acute, and lead to graduate unemployment if unheeded.

No less important and suggestive, however, are the chapters of this report which discuss the evidence on social background, financial assistance and the occupation the candidate had in mind. The latter evidence could well be the most unreliable, and seems to show the large opportunity for public relations work, emphasized in the White Paper on Technical Education and elsewhere, in order to enable the nation to recruit the much larger numbers of scientists and technologists it needs. It is interesting to note that the sons of teachers are much less prone to enter their fathers' profession than are the sons of medical men and dentists, and while 15 per cent of the men admitted who proposed to enter the medical profession were themselves the sons of medical men, for the teaching profession the proportion was only 5 per cent.

The differences between university groups in the proportion of their entrants receiving no financial assistance or help of one kind rather than another were largely associated with the differing proportions in which their entrants were drawn from the main social classes, though another important factor was the proportionately greater number of university and college awards available in some university groups rather than in others, and the preferences shown for particular universities by holders of awards not tied to a specific university or college. The most revealing of these sections, however, is that which points out, in line with the conclusions of the report on "Early Leaving", that the children of manual workers form a very much smaller proportion among those applying for admission to universities and colleges in Great Britain and Northern Ireland than manual workers form of the adult male population as a whole. Differing environmental influences and aspirations are regarded as much more important than any hereditary influence on the distribution of intelligence in reducing the proportion of boys with manual-working fathers from 66 per cent at the point of entry to the non-fee paying grammar school to 36 per cent at the point of university entry (or 26 per cent if we include university entrants from the direct grant and independent schools).

It is probable that, as the report on "Early Leaving" suggested, much good material is being lost which could increase our supplies of technologists and scientists. If, however, this source is ever to contribute to the supply of technicians, positive measures will be required to deal with the environmental influences and such factors as lack of parental ambition. It may well be necessary to go even deeper, for a tradition of culture and service may also be involved. We cannot encourage materialism and expect an altruistic response. Although this report gives a somewhat reassuring answer to the main inquiry, the mass of material presented affords abundant material for thought, and for further inquiry about the universities themselves. While the universities must maintain their tradition of sound learning and free inquiry, they must also supply the nation with an unending succession of men and women competent not merely to undertake offices in the State with imagination and integrity, but equally to bring to the service of industry and the myriad vocations of the modern world those both technically and professionally competent and alive to the human issues and values with which they will be confronted. If Sir James Mountford's committee has done nothing else, it has given a hint that the universities may have to discard some of the assumptions they make about their students, and work out new methods and new standards for dealing with the applicants for admission now coming forward.

TECHNICAL PROGRESS IN BRITISH INDUSTRY

Industry and Technical Progress

Factors Governing the Speed of Application of Science. By C. F. Carter and B. R. Williams. Pp. viii+244. (London and New York: Oxford University Press, 1957.) 25*s*. net.

THIS book is good enough, and authoritative enough, to make its defects important. It leaves the reader convinced that the authors have themselves achieved a thorough and balanced understanding of the factors upon which technical progressiveness depends, but perhaps equally convinced that this understanding would have been transmitted better if the material had been presented more briefly and with some selective emphasis.

It can be assumed that the authors had no wish to induce or support complacency, yet it may prove that they have done so in one important respect. To demonstrate the objectivity of their approach, which is generally well sustained, they emphasize, in Chapter 1, that they did not start by accepting the view that British industry is less progressive than that of some other countries. They then go on to point out, quite rightly, that some sections of industry are at least as progressive as their counterparts in any other country. Unfortunately, having declared their refusal to accept the generalization before investigating it, and having made reference to special cases which seem to be at variance with it, they do not return to the matter and express any final opinion based upon their studies. As a result, they leave any

reader free, if not encouraged, to conclude that British industry is as technically progressive as industry in any other country. It is true that this is not stated to be so, nor is it likely that the authors believe it, but they blunt a potentially powerful spur to action by leaving the matter in doubt.

The failure to draw conclusions as to the technical progressiveness of industry in Britain relative to that of other countries is due, in part at least, to the failure to find any quantitative means of assessing progressiveness. Throughout the book, the judgment of progressiveness is subjective and qualitative. Although the authors recognize the danger of confusing features regarded as evidence of progressiveness with the factors considered to lead to it, it is a danger which they are unable to avoid completely. This difficulty would have been reduced, and the force of the conclusions presented would have been increased, by the adoption of reasonable, even though admittedly imperfect, quantitative methods of assessment. One such method, well suited for comparison between the state of technical advancement of the whole manufacturing industry of one country and that of another, is to compare added value produced per employee hour, after correcting for differences in the value of money. This measures industrial output in terms of the value set upon it by the consumer, and includes allowance for the technical sophistication of the products. When applied to the whole manufacturing industry of a nation, it gives a sensible measure of the manner in which the basic resource of man-power is reinforced by all those other factors which the authors rightly regard as important, such as manual and mental skills, balance between parts of industry, development and production of efficient equipment, effective use of capital, and general good management.

The same form of measurement is of less value when applied to inter-company comparisons, because there is less justification for regarding individual companies as self-contained systems and similar in kind. Even in this context, however, and particularly for comparisons between units within some one section of industry, measurement of corrected added value per employee hour, or the rate of change of this quantity, could usefully be used as one of several non-subjective means of measuring technical progressiveness.

The authors make a very comprehensive survey of the factors which permit or cause a company to be technically progressive. In doing so, they lay further stress upon some matters already recognized to be of importance, but they also emphasize the importance of other factors which tend to be overlooked. Thus, while they reinforce the generally accepted view that the supply of technologists and scientists is inadequate to enable industry to be as progressive as it should be, they also point out that many sections of industry are disinclined to use scientists at all, and that many scientists who are employed in industry are very inefficiently used. Also, while recognizing the importance of the continuing search for new knowledge, the authors stress the necessity for industry to develop an urge to find, and an ability to use, knowledge already available. As they say, in Chapter 4, "There are many firms in craft industries which have not even taken advantage of 'school text book' scientific principles. Their real problem is not that scientific knowledge is hard to come by, but that they have not begun to want it".

A theme strongly expressed throughout the book is that scientific knowledge and ability must be an integral part of management's equipment, that research needs to be managed in relation to appropriate company objectives, and that there must be ability to comprehend and use the results of research outside the research department as well as appreciation of company objectives within it. Not surprisingly, in relation to these views, the authors conclude that technical progressiveness is seldom found where management is not progressive in its general outlook.

During the course of their discussion of the causes of technical progressiveness, the authors go some way towards disarming earlier criticism by devoting attention to demonstrating the weakness or falsity of most of the arguments used by apologists to explain why Britain is less technically progressive than some other nations. They also show that none of the external factors which tend to obstruct the technical progress of an individual firm is likely to be so serious as defects in its own management.

R. Beeching

A NEW COSMOLOGY

The Dramatic Universe

By J. G. Bennett. Vol. 1: The Foundations of Natural Philosophy. Pp. xliii+534. (London: Hodder and Stoughton, Ltd., 1956.) 42*s*. net.

A. N. WHITEHEAD has said: "It is a safe rule to apply that, when a mathematical or philosophical author writes with a misty profundity, he is talking nonsense". Yet, in another place, this same mathematician–philosopher remarks: "Heaven knows what seeming nonsense may not to-morrow be demonstrated truth". Neither remark is to be taken too seriously, but both may be borne in mind when reading the book under review.

The sub-title of the present volume, the first of two, is "The Foundations of Natural Philosophy", but it must not be inferred that it is a book about physics. Mathematics, physics, and other sciences do indeed make their appearance, but the main concern of the work is to promulgate a highly speculative philosophical system, and the essential ingredients are metaphysics and mysticism. Mr. Bennett is a follower of G. Gurdjieff, a Caucasian Greek mystic, whose ideas have become widely known, principally through the activities of his disciple, P. D. Ouspensky. Gurdjieff, who died in 1949, wrote only one book, entitled "All and Everything", which bears superficial resemblances to Nietzsche's "Thus Spake Zarathustra" and to modern 'space-fiction'. In order to protect it from the idle scrutiny of iconoclasts, it was apparently a deliberate policy of Gurdjieff to make his book almost incomprehensible, so that its full significance, if any, could only be grasped after prolonged study. Mr. Bennett himself says: "After perhaps thirty careful readings, I still discover in it new depths of meaning". We do not know whether Mr. Bennett has adopted a similar plan for his own work but, by chance or design, he has achieved a similar end. Since this review is being written after only a single careful reading, perhaps I may be forgiven if some of the depths of meaning have not been revealed to me.

Eminent physicists have told us, as indeed lesser mortals have sometimes perceived, that the universe is mysterious. Contemplation of the universe, and even of some small part of it, often gives rise to mystic thoughts and emotions, which may or may not have a beneficial effect upon those who experience them. However, whether or not a physicist derives his inspiration from a mystical conception, and conducts his personal life by it, we feel that he should rigorously exclude it from his physics. Mr. Bennett evidently thinks otherwise.

As the basis of his physical theory Mr. Bennett postulates a six-dimensional Minkowskian geometry of the universe. The six dimensions are the four dimensions of space–time and, in addition, the 'dimensions' of 'eternity' and 'hyparxis'. It should be noted that the author uses an esoteric and ill-defined terminology which does nothing to further the understanding of his thesis. 'Eternity' is defined as 'the storehouse of potentialities' or 'the measure of intensity of being', and 'hyparxis' is defined as 'the condition of ableness-to-be'. Using arguments which are, to say the least, obscure, Mr. Bennett goes on to 'explain' certain known facts of elementary particle physics, that is, to fit them into his scheme. Of this I have only two things to say: first, a theory, not directly amenable to experiment, which confines itself to 'explaining' the bases of existing theories, without suggesting further developments, is a barren theory at most; and, second, the 'facts' of elementary particle physics are notoriously evanescent, so that the task of fitting them into a rigid universal scheme seems likely to be an unrewarding one.

Although the intricacies are such that it is difficult finally to assess this section of the work, I none the less believe that the theory has been erected upon an assumption which can most charitably be described as an unwarranted extrapolation. Mr. Bennett argues from the fact that kinetic and potential energy are interconvertible that they must be accorded the same existential status, that is, they must be supposed equally 'real', and he goes on to say (p. 156): "Few people to-day doubt that energy exists and that 'visible matter' is only one of its manifestations. There need, therefore, be no hesitation in accepting the view that potential existence and actual existence are equivalent and interchangeable". In case the reader has any doubts about the meaning of this, I feel it necessary to quote at length a passage which occurs two or three pages earlier. Speaking of weather prediction, Mr. Bennett says: "We are not entitled to say that the fine weather that was still potential at ten o'clock but did not materialize is less real than the rain that is actually falling. The non-actualized fine weather is just as truly a part of experience as the actualized rain. For a different state of consciousness the sun might be shining at this very moment and the sky clear. I can, for example, think of sunshine, and perhaps, with practice, I could even voluntarily produce in myself all the sensations corresponding to sunshine, and thus, for my own experience, be able to actualize sunshine instead of rain. In yet another state of consciousness, two incompatible events might both be present simultaneously to my awareness".

In other places the mists draw aside to reveal a landscape even more bizarre. Mr. Bennett is, for example, a supporter of the biospheric hypothesis, according to which the biosphere, that is, the thin film at the surface of the Earth in which life exists, is a living entity higher in the scale of existence than man himself. Mankind may be regarded, so to speak, as the 'brain-cells of the biosphere'. In case this should be mistaken for mere poetic imagery, let me hasten to add that later in the book Mr. Bennett goes further and describes, not only the biosphere, but the Earth itself, as well as the other planets and the Sun, as beings of higher order than man. Number magic makes its appearance here, as elsewhere in the book—in particular, the magic significance of the number seven. "Every organized structure capable of independent existence has seven independent terms", we are told, and are not surprised to discover that there are seven 'true' planets—'true' planets being so defined that their number is precisely seven.

In his Preface, Mr. Bennett makes the disarming plea: "I can only hope that those who realize that we must, *at all costs*, discover a means of looking at all that natural science has discovered in the last centuries *as one coherent whole* will be prepared to give the method a trial; and, if they are specialists in one or other of the subjects treated, will rather fill in the gaps and correct the errors than condemn the enterprise". (The phrases printed in italics are in bold type in Mr. Bennett's Preface.) I feel strongly that, if one of the costs is the abandonment of scientific method, it is too much to pay. None the less, I have read the book with much enjoyment and no little enlightenment. It should be read by all mathematicians and physicists—as a warning. S. RAIMES

HIGH ENERGY NUCLEAR PHYSICS

High Energy Nuclear Physics

Proceedings of the Sixth Annual Rochester Conference, April 3–7, 1956. Compiled and Edited by J. Ballam, V. L. Fitch, T. Fulton, K. Huang, R. R. Rau, and S. B. Treiman. Pp. xii+368. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 3.75 dollars.

THE Rochester Conference on High Energy Nuclear Physics has been one of the important annual international events in the post-war scientific world. The hospitality of Rochester has been extended to delegates from all countries working in this field, and the 1956 Conference which is reported here was notable for the presence of Russian delegates for the first time.

The proceedings of the 1956 Conference arrived in Britain just as the 1957 Conference was taking place, so that already in this fast-moving field many further discoveries have already been reported. The 1956 Conference was particularly notable for the papers by Segre and others on the anti-nucleons, the production of which in the Berkeley bevatron had been discovered in the year previous.

Theory had predicted the existence of anti-protons long ago, and attempts had been made to find them in the cosmic radiation, and indeed some likely evidence had been found but without definite proof. The anti-protons were finally identified among the particles coming from a target bombarded by the 6 billion volt proton beam of the Berkeley Bevatron guided by magnetic fields. They travelled along a flight path of 80 ft. and were identified by their time of flight and the magnetic selector data combined

with Čerenkov counter detection. Since then the annihilation process has been found and studied—up to 640 million volts being carried away by π-mesons. The large interaction cross-section of the anti-proton with nuclei was discussed by Teller.

Other important sessions of the Conference discussed the rapidly growing experimental evidence for the strange particles and their interpretation. The numerous modes of decay by the K-meson were described, and the evidence for the identical mass and life-time of the charged K-mesons was presented. This led to the theoretical discussion on the problem presented by the identity of the K-mesons, θ and τ, which decay into two and three π-mesons, respectively. The equality of life-time was said to be a 'miracle' not explained by theory. Later in the discussion, Feynman and Young considered the possibility that parity in weak interaction was not conserved—a hypothesis which has been abundantly confirmed during the past year.

There was also much interesting theoretical and experimental information on the interaction of nucleons and of π-mesons with nuclei.

The Conference has undoubtedly provided the best opportunity of keeping in touch with this fast-developing subject. In 1958 the Conference is to be held in Geneva.

J. D. Cockcroft

NEUROPHARMACOLOGY

Neuropharmacology

Transactions of the Second Conference on Neuropharmacology, Josiah Macy, Jr. Foundation, May 25, 26, and 27, 1955, Princeton, N.J. Edited by Prof. Harold A. Abramson. Pp. 328. (New York: Josiah Macy, Jr. Foundation, 1956.) 4.25 dollars.

Tranquilizing Drugs

A Symposium held under the auspices of the American Association for the Advancement of Science, in co-operation with the American Psychiatric Association and the American Physiological Society, and presented at the Atlanta, Georgia, Meeting, December 27–28, 1955. Arranged and edited by Harold E. Himwich. Pp. viii+197. (Washington, D.C.: American Association for the Advancement of Science; London: Bailey Bros. and Swinfen, Ltd., 1957.) 45*s*.

Hormones, Brain Function, and Behavior

Proceedings of a Conference on Neuroendocrinology, held at Arden House, Harriman, New York, 1956. Edited by Hudson Hoagland. Pp. xii+257. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1957.) 7 dollars.

The Pharmacology of Psychotomimetic and Psychotherapeutic Drugs

Conference held by the New York Academy of Sciences, Section of Biology, April 12, 13 and 14, 1956. Consulting Editor: Seymour S. Kety. (*Annals of the New York Academy of Sciences*, Vol. 66, Art. 3. Pp. 417–840. New York: New York Academy of Sciences, 1957.) n.p.

NEUROPHARMACOLOGY has enjoyed immense popularity, particularly in the United States, during the past years, and the number of conferences and symposia dealing with some aspect of the subject is legion. Transactions of four of these are reviewed here. As many participants read papers at several conferences, a great deal of overlap is inevitable, but there is a distinct character to each publication. The rapidity with which statements made at these conferences become out of date is a reflexion on the dynamic interest taken in the subject.

Earliest among the four conferences is the "Second Conference on Neuropharmacology", sponsored by the Josiah Macy, Jr. Foundation. It is written in the discussion style favoured by the sponsors, the speakers frequently being interrupted and the subject being treated as a discussion between members of the group. The main theme of the conference is the action of lysergic acid diethylamide (LSD) and its relation to human schizophrenia. There is also an amusing account of the origin of the work of Osmond and the Saskatchewan group on adrenochrome and adrenolutin as possible hallucinogens.

Next in chronological order is a symposium on "Tranquillizers", held in Atlanta in December 1955 and published in 1957. The first part deals with methods used for screening potentially useful drugs or to analyse their mode of action by physiological and biochemical methods. The second part brings the results of treatment of psychoses, the most important drugs being chlorpromazine and reserpine. Two new drugs, however, are just appearing on the horizon: azacyclonol (Frenquel) and meprobamate (Miltown). Reports on 6–8 months clinical use of these drugs, including double-blind trials, are presented from the Galesbury State Hospital and the Mississippi State Hospital.

The third conference was held in May 1956 at Columbia University's Arden House on the River Hudson. Its title, "Hormones, Brain Function, and Behavior", indicates that it is more concerned with the discovery of the causes of mental aberrations than with their treatment. Not nearly so much progress has been made in recent years on the interrelation of hormones and the nervous system as in neuropharmacology proper. Most of the book reports on the orthodox lines of investigations concerning the action of the adrenal gland, the gonads and the thyroid on behaviour and on metabolism of nervous tissue. One chapter, however, is devoted to the newly-aroused interest in 5-hydroxytryptamine (serotonin) as an agent controlling central nervous activity; it is interesting to see that this substance is classified as a hormone in spite of the fact that its occurrence in the brain is not related to the activity of any endocrine cells.

The latest report, covering a wide range of neuropharmacological topics, is that of the conference held in April 1956 at the New York Academy of Sciences. This is a most comprehensive and up-to-date survey of the actions and uses of the substances which formed the subject of the previous conferences. The actions of lysergic acid diethylamide and 5-hydroxytryptamine form a large proportion of the review, and much progress is reported in the analysis of the bio-electrical phenomena correlated with the action of these drugs, in the study of antagonists and in the understanding of the underlying biochemical events. Concerning the drugs used in therapy, progress has not only been made in determining their electrophysiological and biochemical actions, but also in observing the behavioural changes produced in animals and, most important, in using them judiciously in the therapy of psychoses. Indications for a particular drug or drug combination have become more precise, and there has been some success in the avoidance of crippling and undesirable side effects.

Marthe Vogt

SUPPLY OF SCIENTISTS AND TECHNOLOGISTS FOR INDUSTRY

THE report on "Industry and Technical Progress"* contains a key chapter on the supply of "Trained Men and Women", and a conference organized by the British Association was held to discuss this subject, under the chairmanship of Sir Henry Tizard, at the University of Leeds on July 5. In welcoming this well-attended Conference on behalf of the University, Prof. J. T. Whetton emphasized that the problem has many roots, some of which go deep into the schools and the social system. The additional recruits required for British industry cannot be produced like rabbits out of the additional hat now being provided by the expansion of facilities in the universities and technical colleges, and Prof. Whetton's concern about solving the equation of supply and facilities became a recurrent preoccupation throughout the day. Mr. R. J. Butler welcomed the Conference on behalf of the Leeds Chamber of Commerce, and asserted that cost-consciousness is not an inferior aspect of an engineer's work but a vital part of it, for which appropriate training should be given both before and after entry to industry.

Six main points were stressed by Prof. B. R. Williams (University College of North Staffordshire) in a brief introductory survey of the report, of which he is joint author. First, the use of science by industry is not simply a matter of buying a few scientists and providing a back room; rather it is essential to have the widest spread of scientifically minded people throughout the firm. Secondly, the complex chain of relationships between firms has been shown to have a powerful cumulative effect on productivity, or the lack of it. Linked with both these aspects, and of critical, indeed over-riding, importance is the quality of management. Where management is good, so generally is the use of science and technology in the firm. The total supply of technologists is extremely important, but the case studies have shown the critical lack of 'hybrids', that is, people who have mastered more than one discipline, be it mathematics and chemical engineering, physics and metallurgy, or engineering and economics. Finally, finance is not nearly so serious a problem as the shortage of scientists and technologists and the quality of management. We should know when we had solved this problem when finance once more became the limiting factor.

"Behind all the factors affecting our study stands the question of the supply of able minds—managers, scientists and technologists; and it will be seen that we are satisfied neither with the effectiveness of the British educational system in its work of selection of training, nor with the distribution of trained talent between industries and firms." With this quintessential quotation from the report, Sir Henry Tizard introduced its co-author, Prof. C. F. Carter (Belfast), who stressed two aspects of this question. First was the supply of first-rate ability, which is a question of nurturing what we have: secondly was the lack of training of various kinds, which may be dealt with by official policy. Prof. Carter indicated possible lines of action which the Conference might consider; for example: that employment advisory services for young people should operate in grammar schools before the crucial age of specialization and not at the time of leaving school; that allowances, subject to a means test, should be given to children remaining at school after the age of fifteen; specialized university entrance should be greatly relaxed; that consideration be given to a two-tier system of university degrees in science; that more research be undertaken into the teaching of mathematics, and into the elimination of much drawing-office work, and by the professional institutions into the efficient use of scientific and technical staff in industry.

With Sir Ben Lockspeiser in the chair, the second morning session began with Sir Alexander Fleck stressing industry's responsibility as a provider of scientists, as well as in receiving them and using them properly afterwards. In both respects, however, he was concerned with wider education conducive to good personal qualities and powers of leadership. There is urgent need to achieve a new balance between science and the arts, and Sir Alexander commended both the courses at the University College of North Staffordshire and the new proposals at Cambridge. Careful examination should be made of the use of scientists in industry, but there is a proper place for them on the sales side, especially on the way to top management, and this is not fairly described as 'edging nearer the till'. In Imperial Chemical Industries, one in four are engaged on research and development; for the other three a high degree of technical efficiency is desirable, but personal qualities vital in teamwork and leadership are at least as important. Education and training must take account of these trends, which are bound to continue, and science could no longer be regarded as an optional extra to traditional subjects. The education of the scientist must prepare him to take a full part in the management of industry.

The worst shortage in the atomic energy industry, that of design engineers, was discussed by Sir Christopher Hinton. There is no general agreement as to the training of engineers, because it is inherently more of an art than a science, and this art can be learnt only by practical experience in industry. For this reason, though some expansion was justified, a large expansion of university engineering schools would be a serious mistake. More should come through the technical college route, with early industrial experience to get the real feel of engineering, and with concurrent or closely related theoretical study. Sir Christopher illustrated this by reference to the design office establishment of the Atomic Energy Authority at Risley. Of 158 professional staff only fifty-three have degrees, and some of these were external degrees taken part-time through the technical colleges. The remainder had come via the part-time day- and evening-class route alongside industrial experience. Of 226 at the assistant designer grade, only seventeen have degrees, but this 226

* Industry and Technical Progress: Factors Governing the Speed of Application of Science. By Prof. C. F. Carter and Prof. B. R. Williams. Pp. viii+244. (London and New York: Oxford University Press, 1957.) 25s. net. (See also p. 301 of this issue of *Nature*.)

forms the main source for supplying the professional grade. There are 286 in the drawing office grades and none has a degree, but they are very good design staff. This was the total establishment which had been responsible for the solution of major engineering problems in the atomic energy developments. Conversely, of ninety experimental officer grades, forty-seven had degrees, but the posts needed only the General Certificate of Education at advanced level in two subjects. Sir Christopher was very concerned about the consequent waste of university places in a period of great shortage. At the same time, he was equally concerned about what industry did to graduates after entering employment. After ten years employment, British graduates too often compare unfavourably with those in United States industry in vigour and initiative.

The wider education and effective training of graduates in industry was then examined by Guy Hunter, deputizing for Sir Reginald Verdon-Smith (Bristol Aeroplane Co., Ltd.). These are essential both for good management of industry and the general well-being of the nation; the latter especially, since such graduates increasingly occupy key positions, and will greatly influence the transmitting of the national tradition of moral, social, political and cultural values, and will also lay the foundation for the much greater weight of technology needed to sustain modern society. Industry should organize two-year postgraduate training as continued education as well as industrial training, preferably on a sandwich basis, with the universities, advanced technical colleges and industry itself supplying the varied advanced teaching required.

The afternoon session under the chairmanship of P. A. Macrory (Unilever) was devoted to the concern of the schools, colleges and universities with the supply of scientists and technologists. Dr. A. D. I. Nicol (University of Cambridge Appointments Board) was concerned with the unpredictable nature of State scholarship and open scholarship results. For example, of the State scholarship students of mathematics at Cambridge, 70 per cent had obtained only third-class honours degrees. More pass and general honours degree courses might be run for those who aim at technical careers apart from research, but the able scholars should not be sacrificed to these requirements. For them a four-year course or more postgraduate courses are now essential. In the schools a taste for advanced mathematics must be more widely cultivated, since it is the universal language of modern science, and all understanding is limited if some mastery is not attained in it.

As he had first-hand knowledge of it in his local education authority area, A. B. Clegg (chief education officer, West Riding of Yorkshire) was concerned with the problem as to why only 6 per cent of the children of unskilled workers capable of doing sixth-form work actually remain at school, as against 44 per cent of the children coming from professional and managerial classes. He examined the cumulative effects of two main causes, lack of parental ambition and the educational handicaps of the social background of many of the children of unskilled workers, and considered that the role of the school, in offsetting these serious drawbacks, should be to provide a broader education and background to literacy, and to develop wider interests and easy social relationships. But all this is increasingly limited by specialization, rising examination standards, and especially by the impact of the open scholarship system of Oxford and Cambridge. It bears most severely on the socially handicapped able child, in a school likewise handicapped. Unless this difficult matter is dealt with, it may become as highly charged politically as the 'eleven-plus' test has become since the Second World War, and it may well invite increased government probing into university affairs. With suitable safeguards, some experiments should be made in allowing such schools to nominate their own university entrants, when the errors are unlikely to exceed the 17 per cent or so now typical of local authority awards.

From the angle of technical education, Dr. P. F. R. Venables (Birmingham College of Technology) found some encouraging trends since the White Paper was published. A new structure is emerging, more allied to the needs of industry: local and area colleges concerned with courses for technicians and craftsmen, some eighteen regional colleges (rising possibly to thirty) concerned with advanced courses for the foregoing and a limited number of courses for technologists; and the eight (probably ten) colleges of advanced technology concerned solely with training scientists and technologists. Part-time day release enrolments have already increased by about 8 per cent, City and Guilds examination results by 13 per cent; full-time advanced courses have risen by 9 per cent, and similar part-time day courses by 4 per cent. Sandwich courses had an intake of some 1,200 as compared with an output of about 500 the previous session. Of 173 sandwich courses which have now been started, twenty-five have been recognized by the Hives Council for the new diploma in technology (in addition there are six full-time courses so recognized). Qualitative problems noted in the report under discussion are being met by the introduction of industrial administration, economics and related subjects, and of liberal studies, into all undergraduate courses. Nevertheless, there remains serious cause for concern in the wastage of ability in part-time courses, the lack of women students, insufficient training after entry into industry and, above all, the continuing critical shortage of highly qualified teaching staff.

Coming at the end of the various papers and earlier discussion, C. H. Wilson (University of Leicester) tried to put some points in perspective. Too many mutually contradictory arguments had been used; for example, that standards should be raised in the universities, while they should admit many more by lowering faculty requirements and abolishing the scholarship system. There was also a complete lack of reality in piling ever more tasks on to the universities: the quinquennial grants had been fixed, and therefore their potential work was already limited, and additional suggestions must remain pipe dreams. Mr. Wilson cited as evidence of loss of ability the fact that of those leaving the public schools at seventeen and eighteen years of age, only 44 per cent went on to university and other advanced education, and the figure for maintained grammar schools was 41 per cent. The perseverance for science and mathematics courses was greater, the respective figures being 81 per cent for public schools and 50 per cent for maintair d grammar schools. Numbers should be increased without lowering standards, by rescuing the general degree from the neglect into which it has fallen; but industry must first make up its mind as to what proportion of specialists (honours degree men) it wants in comparison to those whose future occupations require a good general science training.

The task of summing up the contributions of thirteen speakers and twenty-four participants in the discussion was allotted to Sir Henry Tizard, but he wisely preferred to round off the conference by stressing only a few salient points. If the supply of scientists and technologists who will remain as such is doubled, it will probably be adequate; but a very much greater increase is required in the number of scientifically educated people for industry, and indeed all walks of life. Specialization has no evils for the able man, and the university and advanced college are appropriate places for this specialization. Not so for the remainder, and greater care must be taken to secure a wider education for them. Everyone agrees that the British educational system is not meeting modern needs, but there has been substantial progress in the schools, colleges and universities. In his day at Westminster School, Sir Henry said that only one other boy was studying science; now the yearly increase is 10 per cent and the science sixth will soon equal the rest. Technical education is progressing rapidly in quality and quantity, and should be given far more money for its needs. A comparative survey of the systems of all the western European countries is urgently needed. Though universities are complaining, Sir Henry said that he knew of no other European government which makes a recurrent grant equal to £31 million per annum to universities. How do those universities manage? And what light would such a survey throw on British university organization? Far more trust is needed between the universities and the schools in Britain, and one of the younger universities should take the initiative in making closer direct examination and nomination arrangements with selected schools. A pilot experiment, conducted some years ago at the Imperial College of Science and Technology, London, had improved relationships and the number of first-class people coming forward.

Well organized as the conference was, it had too crowded an agenda, with an almost breathless succession of speakers and participants. An opportunity was lost in not spreading the same programme over two days, with far more ample opportunity for discussion, and particularly for members to question the authors more closely upon many aspects of their valuable report.

P. F. R. Venables

CAPITAL FOR SCIENTIFIC DEVELOPMENT

THE conference on "Capital for Scientific Development" at the Royal Society of Arts on June 27 was the earlier of two conferences arising out of the inquiry conducted by the Science and Industry Committee of the Royal Society of Arts, the British Association and the Nuffield Foundation into the possibility of speeding up the application to industry of the results of scientific research. The other conference, on the supply of scientists and technologists for industry, is surveyed in the preceding article. In opening the conference the President of the Board of Trade, Sir David Eccles, suggested that the weakness of British industry lies in failure to pay enough attention to the cost of applying new processes and machines, and that the value of Profs. Carter and Williams's book lies in stimulating thought about industry and technical change, and in challenging generalizations too broad to be true. Sir David agreed that company taxation might be less of a deterrent than some people think, but said that it mattered what they thought and that the answer depends on whether, assuming any rate of taxation, the public sector would leave the private sector enough savings.

The subject was dealt with in two sessions devoted respectively to large and small firms, but the discussion was preceded by a short account of the survey by Prof. C. F. Carter, who summarized its findings on this point. At the time of the survey many firms were certainly not held back by lack of finance, although they might be described as stagnant pools. Others, including some highly progressive from a technical point of view, had their development limited by the difficulty of retaining enough money in a period of high taxation, or by their inability or unwillingness to raise money from outside. Prof. Carter suggested that the problem, in its broadest terms, was whether the supply of savings was as high as it could reasonably be made, and whether our financial machinery was such that these savings were available to the investment borrowers with the best claim. These questions raised very wide issues, some of which, including the place of the National Research Development Corporation in the financial support of key developments, Prof. Carter indicated.

The discussion on the position of the large firm was opened by Lord Dudley Gordon, who thought that new capital was normally required to develop the results of research in an existing department, and he found it hard to accept the suggestion in the report that a board of directors might refrain from increasing a dividend so that it may have funds to erect a new factory. Lord Dudley observed that surpluses shown are not usually available as cash, and new development resulting from research has to be paid for in cash. Large sums have also to be found for maintenance and repairs and to comply with the provisions of such measures as the Clean Air Act, and nearly every major project involves raising additional capital in some form, rather than cash from internal resources.

Sir Nutcombe Hume, who opened the discussion on the smaller firm, said that the conclusions drawn by Profs. Carter and Williams on capital for development accorded with those reached by the Charterhouse group of companies, of which Sir Nutcombe Hume is chairman, as a result of their experience in this field. Sir Nutcombe thought there were all too many men in responsible managerial positions, especially in the smaller companies, who did not know the extent of the facilities available and their uses. An essential ingredient of good management was the realization that, at least in matters of finance, a company must choose some reputable finance house and trust it to do what is best for the company. He also pointed out that the minimum size for a company to prove attractive to the Stock Exchange and investors seeking a free market in the securities they hold had been growing for many years, and he did not think that the report distinguished strongly enough between capital in the

form of borrowed money and that in the form of share capital. It was thoroughly bad that the incidence of profits tax should favour borrowing money and put such a heavy burden on ordinary share dividends, but he agreed with the authors of the report that too much time and energy were occupied by the problem of death duties.

Apart from this, few of the issues specifically indicated by Prof. Carter were mentioned by the other speakers, though Prof. Carter did not suggest that they would necessarily be discussed. Some of these points may be mentioned in conclusion to indicate that something more was done at the conference than to ventilate a pressing problem of modern industrial development and to seek possible solutions. There is the question whether there is a right balance between compulsory and voluntary saving; is it good or bad for technical progress that so much capital investment should be financed from ploughed-back profits; are the inducements and privileges given to private savers sufficient, or could a useful increase in private saving be obtained by further inducement? Again, are selective means of encouraging specially productive industries needed and can we make better use of men with ideas but no great ability in finance or sales? What is the place of general measures such as the investment allowance and do frequent changes diminish their efficacy? Is there any better way of controlling fund-raising from the markets than the present Capital Issues Committee, or would it be better for technical progress if capital were rationed by prices? Is there any better way of ensuring finance for small companies which unite technical progressiveness with business competence, and can anything be done to allay the fears of small firms which inhibit them in seeking outside finance?

SMOKING AND LUNG CANCER

REPORT OF THE TOBACCO MANUFACTURERS' STANDING COMMITTEE

THE tobacco manufacturers of Great Britain, disturbed by the reports that the evidence for a close relation between smoking and lung cancer was piling up, gave in 1954 a fund of £250,000 to the Medical Research Council for furthering research on the subject. Not satisfied with the results of their philanthropy, the manufacturers are now about to set up a new fund for research to the tune of £1 million. Their Standing Committee consists of technical representation from the different companies, and a scientific consultants panel of two eminent scientists, namely, a chemical technologist and a statistician-geneticist.

The report issued by the Standing Committee (6–10 Bruton Street, London, W.1), dated June 17, 1957, shows undisguised attempts to belittle the findings of those investigators who have shown a correlation between smoking and lung cancer. For example, it points out that one's daily intake of benzpyrene in the air in a West Country town is equivalent to the benzpyrene content of the smoke from forty cigarettes and the daily intake in London to the benzpyrene from one hundred cigarettes. These statements could imply that the best-known carcinogen (benzpyrene) present in cigarette smoke can be ignored as a factor in the lung cancer–smoking relation, since the air already contains more benzpyrene than the amount to which the great majority of smokers are exposed. Unfortunately for this idea, the lung cancer rate has been rising rapidly in many places all over the world and including towns in Norway, Iceland and Denmark, where the air is far less smoky than in English towns and where, as a consequence, the benzpyrene content of the air is a small fraction of the English figures. Moreover, women have a much lower lung cancer rate than men, although they breathe the same air.

Nevertheless, the laboratory work of the Committee is largely concerned with the measurement and the formation of benzpyrene in cigarette smoke. The report records that the arsenic content of cigarettes is declining due to alterations in the pest-control technique on the tobacco crop. However, the implication that arsenic in the smoke could be the responsible carcinogen is undermined by the available lung cancer figures for Turkey, where the disease is about as common as in other European countries, but where the tobacco contains scarcely any detectable arsenic.

Although the report begins by rejecting the lung cancer–cigarette relation, its laboratory work energetically pursues the theme that cigarette smoke contains carcinogens such as benzpyrene, arsenic, dibenzanthracene, or some as yet unknown carcinogen lurking among the other constituents of cigarette smoke, which are identifiable or have still to be defined.

The report brings its heavy guns to bear on the statistical aspect of the problem. It emphasizes that a contingent statistical relation does not guarantee causation. Let us take an example of what could be called contingent. Seaside-sunburn in London school children, before the motor-car, was always preceded by a railway journey. The railway journey is contingent to the sunburn but is not the cause of the sunburn. To take a strictly practical point of view, the seaside-sunburn could have been avoided by shutting down the railways, and in the same way lung cancer could be largely avoided by closing the cigarette factories, quite independently of whether lung cancer and smoking have a causal *or* a contingent relationship.

The report refers to the 'genetic factor', that is, a hypothetical factor present in part of the population which determines not only susceptibility to lung-cancer but also a disposition to seek tobacco. Then why did not this genetic trait show itself before the lung cancer epidemic got under way, at about 1910–20?

A further theme pursued in the report is the alleged imperfect randomness of the patients who were the subjects of the Doll–Hill investigation. Surely, non-randomness is what is required: to

choose parallel lung-cancer and non-lung-cancer patients for comparison whose other differences have been cancelled out with the exception of one variable, namely, smoking or non-smoking. This Doll and Hill did: they studied 1,357 men who had contracted lung cancer and the same number of men free of lung cancer as controls, together with 108 women suffering from lung cancer and 108 women controls. The patients and their controls were in the same hospitals in London, Birmingham, Cambridge, Leeds and Newcastle and in rural areas of Dorset and Wiltshire; they belonged to the same age group, had been in hospital for the same length of time, and the controls even had the same disease (cancer) of some other part of the body. It would be difficult to imagine a more carefully worked out scheme of matched controls. The results of the Doll–Hill investigation are now too well known to need reiteration.

The report develops the argument that modern therapeutic methods have allowed age groups liable to lung cancer to survive which would previously have had large losses by death at a less advanced age. Let us then assume that the steep fall in the tuberculosis death-rate since the latter part of the past century has saved susceptible groups for a later death from lung cancer. But what of the women? Their death-rate from lung cancer is much below that of the men. It will be necessary then to postulate a second hypothesis, that lung cancer is sex-linked. But our difficulties are not over, for the lung-cancer rate for women has been rising quite rapidly. For the moment, this line of argument is better abandoned.

I. Hieger

THE NATIONAL COAL BOARD'S PNEUMOCONIOSIS FIELD RESEARCH

By Dr. J. W. J. FAY
Chief Scientist of the Research

PNEUMOCONIOSIS is a condition which starts almost imperceptibly with the fixation of a small amount of dust in the lung, and as the period of exposure increases more and more dust is accumulated. So long as the condition remains as 'simple' pneumoconiosis, it is believed that it will not progress if the subject is removed from the dusty environment, and disability is absent or comparatively slight. The rarer but more serious form is known as 'complicated' pneumoconiosis, or progressive massive fibrosis. In this form of the disease the patient's condition deteriorates even if he is removed from the dusty environment. Progressive massive fibrosis is thought to be caused by the superposition of an extraneous infection, probably tubercular, on a background of simple pneumoconiosis usually in its more advanced stages. Hence, if pneumoconiosis is halted at the earlier stages of the simple form, the results are not serious. Both forms of the condition are recognizable by X-ray examination of the lungs.

In spite of the work which has already been done, pneumoconiosis still presents a serious problem in the coal-mining industry, about five thousand new cases being certified every year. The National Coal Board has therefore undertaken a field research to study the effect of the dust breathed by coal-miners in the course of their work. As the result of long-term field studies it is hoped to obtain accurate data on which to base safe levels of dust concentrations which miners will be able to tolerate throughout their working lives without suffering any considerable disability.

The research, which was started in 1953, is being conducted at twenty-five collieries in England, Scotland and Wales. The selection of collieries is designed to provide a reasonable cross-section of mining practices, conditions and types of dust, in order to investigate the effect of composition as well as quantity of dust. These twenty-five collieries employ about 35,000 men, approximately 5 per cent of the coal-miners in the United Kingdom.

Medical Studies

There are two mobile medical units, each equipped with the most up-to-date X-ray machines for taking full-size chest X-rays of the population at each colliery every three years or so. Each unit is in charge of a senior medical officer and includes a qualified physiologist, a radiographer and clerks, technicians and ancillary staff to a total complement of nine.

The films are classified into categories of pneumoconiosis according to the international (I.L.O.) classification, which recognizes four stages of simple pneumoconiosis and four of progressive massive fibrosis.

The reading of the films is done by the senior medical officers. Due precautions are taken to estimate the accuracy and consistency, including the application of cross-checks and a continuous statistical control on the reading levels. By this means a uniform and satisfactory standard of reading is maintained.

The first round of X-ray surveys has been completed, and the results have shown a wide range of prevalence of significant pneumoconiosis at the different collieries.

At the time of the X-ray survey, details have been recorded of the past working histories of all the men examined. There is thus available a record of the prevalence of pneumoconiosis on an individual basis among the present populations at the collieries, together with a record of the environmental history which has contributed to the prevalence revealed. This information enables an estimate of the prevalence throughout the coalfields to be made.

The examination is voluntary, but the co-operation of the men has been extremely good, the overall response being about 95 per cent. The lapses have been analysed in terms of age and occupation and they do not appear to be significant in either respect. Thus the population examined is considered to be representative of all the men working at the collieries at the time of the surveys.

The second round of medical surveys will be started this year, and a number of simple anthropometric and physiological measurements will be made in addition to the X-ray examinations. This is in order to investigate the relationship between X-ray classification and disability. In addition to the physiological tests, which are primarily intended to investigate respiratory function, a questionnaire will be used for eliciting information regarding other chest conditions which may complicate the investigation of pneumoconiosis.

Environmental Measurements

The environmental sampling programmes are designed to measure the environments of the men, particularly dust concentrations, for the purpose of correlating the attack and progression of pneumoconiosis as revealed by the follow-up X-ray surveys with the intervening dust exposure which has caused it.

An individual record of dust exposure is required for each man under observation, to match against his X-ray record. The system adopted to accumulate the necessary data has been to stratify into occupational groups the population of each colliery and to get a measure of the environment of each group. Each occupational group consists of men doing the same work, at the same time, in the same place, so that the environment within any one group can be expected to be reasonably uniform. The sampling procedure is to select representatives randomly by name from each of the groups and to measure their exposure throughout a working shift. Different representatives are covered on successive shifts of sampling and, by a suitable choice of sampling fractions, occupational group exposure indices are built up with increasing accuracy as time goes on. These occupational group exposure indices are attributed to each man in the group for the period he spent in the group, and in this way an individual exposure index is cumulatively recorded for each man under observation.

The dust concentrations are measured by investigators based at the collieries who accompany the representatives throughout their working shift. The thermal precipitator is used as the standard instrument, and the dust concentrations are evaluated in terms of the 1–5 micron particle counts, as representing the best practical method of assessing the respirable dust. There are sixteen senior investigators (scientists) engaged in these field studies, each being responsible for the work at one or two collieries. They are assisted by thirty-nine junior investigators (scientific technical officers), giving a total field team of fifty-five, an average of just over two investigators at each colliery. The actual distribution of staff depends upon the size of the colliery. The environment of the whole colliery population is measured, and a picture is built up of the dust exposures of all the occupational groups on all shifts.

The sampling procedures are standardized and the performance of the investigators in evaluating their samples is subject to continuous check. In this way satisfactory counting levels have been attained and maintained by the team as a whole throughout the investigation.

The success of the system of sampling by occupational groups depends upon maintaining an accurate record of each man's working history. At any one time there are about 1,400 occupational groups altogether, with considerable movement of men from one group to another. Records must therefore be kept of changes in occupation, and the methods for doing this have been successively refined as the investigation has proceeded. The system which has finally been developed involves the use of individual mark-sense Hollerith cards which are prepared by a clerk at each colliery. The cards are mechanically punched, sorted and summarized on a Hollerith machine at headquarters in London to provide a detailed record of environmental exposure, due allowance being made for the man's time at risk.

The emphasis so far has been on the measurement of dust concentrations in terms of total particles of respirable dust, but the question of composition is covered in two ways. The thermal precipitator slides are evaluated regularly in terms of coal and non-coal particles in order to record what proportion of the 1–5 micron dust is mineral. In addition, work has been started on the collection of gravimetric samples of the various dusts for composition analysis, inuding an estimate of the free silica content.

Correlation of the Medical and Environmental Data

The ultimate object is to correlate the observed progression of pneumoconiosis with measured dust exposure. In the first place, the hypothesis to be tested will be that radiological pneumoconiosis is related to dust exposure expressed in terms of the number of 1–5 micron particles per unit volume of air. Alternative hypotheses will have to be investigated if this simple hypothesis is disproved. For example, it may be necessary to take account of the composition and size distribution of the dusts, as well as to investigate the effect of very high intermittent, or 'peak', concentrations. It is, however, impossible to undertake any analysis based solely on the observed progression and measured dust concentrations until at least one follow-up X-ray survey has been made and some progression measured.

Hence the analysis is limited for the time being to an examination of the present prevalence in terms of past occupations. The past working histories taken during the first X-ray surveys have been summarized and analysed in terms of prevalence of pneumoconiosis and period of exposure in the different occupations and places of work. In this way it is possible to obtain information about the relative hazards of different occupations at the various collieries in the past, which will provide a useful background of knowledge for the quantitative correlations later in the investigation.

The planning and supervision of the environmental sampling programmes and of the medical/environmental correlations, as well as the development of new techniques and methods of analysis, are carried out by a headquarters unit consisting of eighteen scientists and technologists and twenty-four clerical and ancillary staff—a total complement of forty-two. With the eighteen people associated with the medical units and the fifty-five investigators in the field, there are thus 115 people engaged full time on the investigation.

The investigation is still in its comparatively early stages and much of the effort to date has inevitably been devoted to the design and application of the long-term procedures. This account has therefore

been largely limited to a description of the background and planning of the investigation. The results so far available are preliminary ones, but those which are of general interest will be published from time to time.

It is impossible to acknowledge in detail the help and encouragement which are forthcoming from so many people. Without this co-operation, however, it would obviously be impossible to conduct the investigation, which can safely be said to represent a good example of a large-scale, co-operative experiment in the field of occupational hygiene.

This short statement of the programme of research is published by permission of the National Coal Board.

NUCLEAR RADIATION MEASUREMENTS DURING THE INTERNATIONAL GEOPHYSICAL YEAR

By Dr. BERT BOLIN
International Meteorological Institute, Stockholm

THE development in the field of nuclear physics in recent years has indeed been remarkable. Not only has our understanding of the principles of nuclear reactions been vastly increased, but refined techniques for identifying and measuring radioactive isotopes in exceedingly small amounts have also been developed. These latter methods have been of great use in biological and medical studies; of late they have been applied to geochemistry, and are now finding their way into geophysics. A new and powerful tool for studies of our environment has thus been placed at the disposal of the Earth scientists, the ultimate possibilities of which we cannot judge to-day. It is highly desirable that the great promise of this field be realized and a global observational programme formulated, particularly in view of the intimate world-wide co-operation in all fields of geophysics during the International Geophysical Year 1957–58.

A number of natural radioactive elements are found in Nature, the existence of which has told us interesting facts about, for example, the history of the Earth, the exchange processes in the atmosphere and the sea as well as through the interfaces between these media. Thus determinations of beryllium-10 in deep-sea sediments may be of importance for studying the chronology of the bottom floor; the distribution of the much more rapidly decaying isotope beryllium-7 might yield interesting information about the horizontal large-scale mixing in the atmosphere. Determinations of carbon-14 in the sea and atmosphere have given much more precise knowledge about the exchange of carbon dioxide between the atmosphere and the ocean, and may very likely tell us something about the speed of circulation of the deep ocean. Similarly, studies of the radium and ionium content of the deep sea throw some light on the water motions in the bottom strata of the deep sea. A number of investigations of radium and thorium and their daughter products have given us better knowledge of exchange processes in the surface layers of the atmosphere.

In the past twelve years an increasing number of radioactive elements have been introduced into the atmosphere through nuclear weapon tests. In a thermo-nuclear explosion more than one hundred different radioactive isotopes are formed directly or indirectly. Most of these isotopes were previously not present in measurable amounts in Nature, while in other cases this new source means a contamination of the natural reservoirs of radioactive elements. Thus the amount of tritium in the atmosphere, sea and lake waters has significantly changed due to these experiments. It may, therefore, now be difficult to determine precisely the amount of tritium on the Earth that is of natural origin. On the other hand, the variable input of tritium by man into the atmosphere, and its propagation in the water-cycle, will probably yield interesting information about this cycle itself, that might have been difficult to find using only the naturally formed tritium. Other radioactive isotopes produced by nuclear weapon tests are strontium-90 and cæsium-137, the distribution of which has already revised our ideas about the vertical exchange in the stratosphere, and most likely will be of great importance for the study of the general circulation of the atmosphere.

Already measurements of the total amounts of man-made radioactivity deposited on the ground have shown remarkable variations. Meteorologists might earlier have thought of the motion of the atmosphere as a large-scale turbulent process, but observations of the radioactivity of the air reveal details that would have been very difficult to obtain by any other method.

In view of the large observational programme in all fields of geophysics during the International Geophysical Year 1957–58 it seems highly desirable also to organize a programme for observations of radioactive elements in Nature. Quite a large observational network for measuring the radioactivity of the air and the deposited radioactivity has been reported to the United Nations, but the question of health hazard has been the main objective in the organization of these observations. It seems that the purely geophysical and geochemical aspects of the problem deserve a much more detailed examination. Recognizing this the Special Committee for the International Geophysical Year (CSAGI) in September 1956 endorsed a recommendation that a programme be formulated for measuring, on a world-wide basis, the nuclear radiation of air and precipitation and of solid particles deposited on the ground. Based on this recommendation a Working Group on Nuclear Radiation met at Utrecht during January 22–26.

The programme adopted by the Special Committee for the International Geophysical Year should be looked upon as a minimum programme. In view of

the short time available for preparations before the beginning of the International Geophysical Year it was felt most important to start a basic programme which might then gradually be expanded. It is quite clear that most of the observations suggested should continue after the end of the International Geophysical Year, and therefore observations starting during the Geophysical Year would be of great value to future work in this field. Furthermore an Advisory Committee on Nuclear Radiation has been appointed to co-ordinate these efforts. This may be even more necessary here than in other disciplines, partly because of the short time still available for preparations, and partly because the programme covers a number of different fields in geophysics, such as cosmic radiation, meteorology, oceanography and glaciology. The chairman of the Advisory Committee is Dr. W. Bleeker, of the Royal Netherlands Meteorological Institute, de Bilt. It was also considered important to keep in close contact with the United Nations Special Committee and the World Meteorological Organization on this subject.

Essentially four observational programmes were outlined in the recommendations from Utrecht.

Measurements at ground-level of: (*a*) particulate airborne fission products; (*b*) the deposition of fission products in precipitation and as dry deposits; (*c*) the natural radioactivity of the air.

In the first place the programme aims at measurements of the total activity of air and precipitation, which would be of considerable interest, for example, as identifiers of air-masses. Where technical facilities exist for more detailed analyses of the samples the following isotopes were considered as of particular interest to the geophysicist, namely, strontium-89 and 90, cæsium-137, bismuth-210 and polonium-210.

Observations of radioactivity of the air in the free atmosphere. It is clearly realized that one can scarcely expect a fully world-wide network to be established for the International Geophysical Year. A knowledge of the distribution of the radioactivity in the free atmosphere is, however, of fundamental importance for a correct interpretation of the fall-out pattern at ground-level. Even a small number of additional measurements would be of great value in this respect, and would thus supplement the programme of measurements at ground-level. Furthermore one may hope to achieve a more complete network at an earlier date by extending international collaboration at the present stage.

Measurements of the tritium content of water before nuclear weapon detonations, for determination of the natural distribution of tritium. The water cycle in Nature is of great interest from many points of view. Tritium offers an excellent possibility for studying this cycle in more detail. In particular the speed of circulation within and between the different reservoirs may be determined. The natural distribution of tritium is poorly known, since nuclear weapon tests have thrown considerable amounts of tritium into the atmosphere. It should be possible, however, to establish the 'pre-atomic' tritium distribution by analysing glacier ice which has not been contaminated by melting. In middle latitudes wine bottled before 1945 should yield representative figures.

Determination of carbon-14 and tritium in the oceans at the surface and if possible at greater depths. Interesting results have recently been obtained about the circulation of the ocean and the exchange between the ocean and the atmosphere of carbon dioxide and water. These results are based upon very few measurements, and it is doubtful if these are truly representative. A world-wide programme for such measurements would be of very great interest both to oceanographers and meteorologists.

Some of the scientists actively engaged in applying these new techniques to geophysical problems may regard the programme outlined above as too limited. It may, nevertheless, be difficult to achieve even this modest goal during the International Geophysical Year. It is therefore necessary to look upon this programme as a first attempt to arrive at international co-operation among geophysicists in the field of nuclear radiation. Geophysicists would profit greatly from such a development. Equally important, however, is the recognition of the fact that geophysicists are needed for the best utilization and interpretation of the nuclear radiation data that until now have been collected essentially by physicists. We should be looking forward not only to international co-operation but also to interscientific co-operation.

OBITUARY

Lord Clinton, P.C., G.C.V.O.

The age of the great landlords of Britain is passing. Heavy taxation limits their activities during life, and death duties break up their estates after they die. But the countryside, agriculture and forestry owe much to these men for their devotion to their estates and their work to improve methods of farming and management of woods.

Lord Clinton, who died recently in his ninety-fifth year, was one who contributed much. It is true that he does not leave behind him a name such as "Turnip" Townshend or Coke of Norfolk, or possibly even that of his friend and colleague Sir John Stirling Maxwell, who introduced modern methods of tree planting. But he was a great landowner owning very large properties in Devon and with estates in Scotland. He devoted his life to the management of those estates, and, except for an interlude when he served with the Devon Yeomanry during the First World War, all his activities were concerned with the land he loved and understood so well.

His personal interest in his estates was such that in effect he managed them himself, extensive though they were. But forestry was probably his greatest interest in land use, and at a time when there was no great encouragement to private forestry he managed his extensive woodlands in the light of the most modern knowledge at the time. His personal interest may perhaps best be shown by the fact that whenever possible he made a practice of marking his own thinnings.

For a short while after the First World War he was Parliamentary Secretary to the Ministry of Agriculture. But with the passing of the Forestry

Act in 1919 which set up the Forestry Commission, he was an obvious choice as a member of the new body, joining his friends Lord Lovat and Sir John Stirling Maxwell. Starting a new venture like this was a landmark in forestry history, and foresters throughout Britain owe much to the hard and difficult work which these pioneers carried out. To all this Clinton contributed greatly, not only from his knowledge of forestry, but also from his experience in public affairs both local and national. From these efforts has risen an organization which those pioneers can scarcely have imagined.

He remained a member of the Forestry Commission until 1930, becoming chairman in 1927. His interest in forestry persisted to the end, and as recently as 1956 he persuaded the Forestry Commission to take over his woods on his New Pitsligo estate in Aberdeenshire to ensure that neither the effects of good management nor his experimental work there should be lost in the future.

Clinton was Lord Warden of the Stannaries in the Duchy of Cornwall during 1922–33, and to this office he was able to bring his great experience of land management. This office means in effect that he was the principal adviser to the heir of the throne in the management of his estates. It is, however, curious that in that office he never succeeded in arousing much interest in forestry in the Duchy woodlands.

He was also chairman of the Lawes Agricultural Trust Committee, the governing body of Rothamsted Experimental Station, during 1924–37. Here again his profound practical knowledge of agriculture and its needs was of great value to a body of scientists who, in common with scientific endeavour in almost all walks of life, had a tendency to be led astray from any practical aspects by their enthusiasm for theory.

During his very active life, Clinton was able once again to show how much Britain is losing by the passing of great landowners such as he. RADNOR

NEWS and VIEWS

Meteorology at Harvard : Prof. Charles F. Brooks

DR. CHARLES F. BROOKS, professor of meteorology at Harvard and director of the Blue Hill Observatory since 1931, is retiring this month and will be succeeded by Dr. R. M. Goody, at present reader in meteorology in the University of London (Imperial College of Science and Technology). Dr. Brooks, who was born in 1891, is perhaps the best loved figure in present-day American meteorology. He is noted for his integrity, courage and helpfulness to others, and these qualities have been most apparent and appreciated in his work for learned societies. In 1919 he set about re-establishing the American Meteorological Society (a task in which others had previously failed), became its first secretary and later treasurer, and by his personal efforts helped greatly to make it the successful institution which it is to-day. He held the post as secretary continuously until 1953. He has also served as president of the American Geophysical Union. Dr. Brooks is a meteorologist of infectious enthusiasm, occupying himself with observations when travelling on business or pleasure. His research work has covered the wide range of the climatology of North America, long-range weather forecasting and the effect of ocean temperatures on weather, instruments, microclimatology, eclipse meteorology, snowfall and clouds. He showed in the early 19_0's that a downdraught was almost certainly an essential feature in the life-history of a thunderstorm, a finding the importance of which has only come to be generally appreciated in the past decade or so.

Dr. R. M. Goody

DR. R. M. GOODY, who was born in 1921, has been a Fellow and Scholar of St. John's College, Cambridge. He took his degree in physics in 1942 and for the next four years worked in the Ministry of Aircraft Production, first testing aircraft and later as a special duties officer in charge of a German research institute in Göttingen. In the course of this later work he was involved with the Control Commission in the first phases of the creation of the Max Planck Institutes. Dr. Goody took his Ph.D. in 1950 and was appointed Fellow of his College in that year. In 1951 he was awarded a Senior Studentship of the 1851 Exhibition and in 1953 he went to the Imperial College of Science and Technology as reader in meteorology. Since the War, Dr. Goody's interests have mainly been in the field of infra-red spectroscopy and its application to atmospheric problems, which has led him into the whole field of radiative transfer problems. He has done notable research on the stratosphere, and is the author of "The Physics of the Stratosphere" (Camb. Univ. Press, 1954). Recent research on the emission of radiation by atmospheric ozone has led him to a new method of determining the vertical distribution of ozone from observations at the ground. At present he is in charge of a small observatory of the Department of Meteorology, Imperial College, at Silwood Farm, Ascot. Dr. Goody will take up his new appointment in the summer of 1958.

The British Rainfall Organization: Memorial to G. J. Symons, F.R.S.

AN interesting dual ceremony was held in Camden Square, London, N.W., on August 8 under the auspices of the Royal Meteorological Society to honour the memory of George James Symons, pioneer in the scientific study of rainfall, and to mark the re-opening of the Society's historic London weather station on a new site. During the years 1854–58, repeated spells of drought made Symons see the need for assessing Britain's potential water resources by means of accurate and systematic measurements of rainfall. For this purpose he set about recruiting volunteer observers, and by 1860 was able to publish records from 168 gauges—all in England and Wales. Soon he extended the investigations to Scotland and Ireland. Public interest in the work grew so rapidly that the number of collaborating observers rose to two thousand within twenty years and reached 3,500 by the close of the nineteenth century. Thus was formed the British Rainfall Organization—a remarkable example of private enterprise supported mainly by voluntary effort. On Symons's death in 1900 he was replaced first by his chief assistant, H. Sowerby Wallis, and, shortly afterwards, by the late Dr. Hugh Robert

Mill, who retained control until the organization was taken over by the Meteorological Office in 1919. Since then it has continued to flourish with a corps of collaborating observers some five thousand strong. The Royal Meteorological Society has now commemorated Symons's great labours on behalf of science and the nation by affixing to the front wall of his former home in Camden Square a bronze plaque briefly recording his achievements and also his presidency of the Society on two occasions. This plaque was unveiled at noon on August 8 by the Mayor of St. Pancras, Councillor T. J. Redman.

The second ceremony on the same day was the formal opening by Dr. R. C. Sutcliffe, president of the Royal Meteorological Society, of a well-equipped climatological station which the Society, with the friendly co-operation of the St. Pancras Borough Council, has established on a chosen site in the small park of Camden Square. This station replaces one originally set up by Symons at 136 Camden Road (250 yards distant) in 1858 and transferred to the garden of his home at 62 Camden Square ten years later. Regular observations were maintained there by Symons and his successors until 1922, and have since been continued (not without difficulty) by the Royal Meteorological Society. These provide the longest unbroken day-to-day record of rainfall, temperature and weather anywhere in the county of London. Quasi-immortality for it is aimed at by the change of site from deteriorating private property more than a century old to an open space under municipal control. The World Meteorological Organization recommends that, for the study of secular climatic change, every nation should strive to keep at least one long-established weather station going in perpetuity. This the Royal Meteorological Society hopes to do at Camden Square.

Dr. Macalister Brew Scholarship Fund

The National Association of Mixed Clubs and Girls' Clubs is establishing a Dr. Macalister Brew Scholarship Fund. Dr. Brew was the Association's education and training adviser for fourteen years. The purpose of the Fund will be to enable young people, less than twenty-five years of age, to secure a term of further education, formal or informal, which they cannot finance themselves and for which no other aid is available. In accordance with the outlook of Dr. Brew, the precise nature of the awards will not be determined in advance but will depend upon needs arising from time to time. Further information about the Fund, together with extracts from some of the many public tributes which have been paid to Dr. Brew, can be obtained from Mr. S. H. Wood, N.A.M.C. and G.C., 30 Devonshire Street, London, W.1, to whom contributions should also be sent, cheques being made payable to "J.M.B. Scholarship Fund".

The Imperial Institute

In reply to a question in the House of Lords on August 1 regarding the Imperial Institute, the Minister of State for Colonial Affairs, the Earl of Perth, replying on behalf of Lord Hailsham, said that a suitable site has been found at the south end of the Holland Park Estate, and negotiations for a building lease, to be held in the first place by the Minister of Works, are at an advanced stage. The Bill which the Government hopes to introduce early next session will transfer all interests in the land from him to the trustees and will also provide for the cost of the new building to be borne on the Vote for the Ministry of Education. Lord Lloyd and Sir Alan Burns, he said, have accepted invitations to fill the place of the retiring trustees, Lord Brand and Sir Alfred Chester Beatty, and Lord Dundee is succeeding the late Viscount Hudson as chairman of the governing body. It is the intention of the trustees, with the help and advice of the governing body, to press ahead with the planning and erection of the new building. Lord Perth said that there will be no break in the work of the Institute, although some inconvenience will be inevitable. Investigations are still proceeding as to whether, in the development scheme for the Imperial College of Science and Technology, it will be possible to leave the Collcutt tower as a free-standing campanile at a reasonable cost.

In a written reply, Lord Perth gave the names of the trustees of the Imperial Institute, in addition to the two already mentioned, as the Lord President of the Council, the First Commissioner of the Treasury, the President of the Board of Trade, the Minister of Education and Viscount Southbury. The board of governors consists of the chairman, vice-chairman (Sir Griffith Williams), members appointed by the Governments of Canada, New Zealand, Australia, South Africa, India, Pakistan, Ceylon and the Federation of Rhodesia and Nyasaland (usually the High Commissioners or their deputies), nine governors appointed by the Minister of Education and three co-opted members.

Health in British Overseas Territories

The Secretary of State for the Colonies, Mr. Lennox-Boyd, stated in a written reply to a question in the House of Commons on July 30 regarding progress in the elimination of malaria and the treatment of leprosy and malaria during the past decade that malaria had been eliminated in Aden, Antigua, British Guiana (coastal areas), Cyprus, Mauritius, Nevis, St. Kitts, St. Vincent, Santiago and Tobago, and projects for its elimination are in preparation or in progress in British Honduras, Dominica, Grenada, Jamaica, North Borneo, Sarawak, St. Lucia, Trinidad and Zanzibar. Prospects in the African territories depend on the results of research and pilot projects in progress. Significant changes in the treatment of leprosy during the past three or four years has resulted in good progress in combating this disease, and provision is increasingly being made, as an alternative to long-term segregation, for out-patient treatment in clinics and rural dispensaries with the sulphene drugs in tablet form. Treatment is increasingly undertaken voluntarily, and in Northern Nigeria there are 468 treatment centres and 104,000 patients under voluntary treatment. Tuberculosis is now regarded as the greatest medical problem in British overseas territories, but in some non-tropical territories, such as Cyprus, Gibraltar and the Falkland Islands, there are indications that the disease is being successfully controlled. B.C.C. vaccination campaigns in Jamaica are beginning to bear fruit, and notification in Trinidad has fallen significantly. Surveys are still being undertaken, particularly in the African territories, with the assistance of the World Health Organization, and increased facilities for treatment have met with a ready response. In Hong Kong, the disease is the greatest single cause of death, but the death-rate is now falling. An

important factor in the progress of the campaign is the attendance of medical practitioners and other personnel from the territories at tuberculosis courses in the United Kingdom.

Colleges of Advanced Technology

QUESTIONED in the House of Commons regarding the progress of the designated colleges of advanced technology, the Parliamentary Secretary to the Ministry of Education, Sir Edward Boyle, said in a written answer on August 1 that, at Bradford, Salford, and the Welsh College of Advanced Technology, Cardiff, new governing bodies have been set up, and at the other colleges the schemes of government have been modified, especially to give better representation to industry and commerce and other outside interests. At three of the colleges, new principals have been appointed and at all of them extra staff is being recruited. During 1957–58, the three colleges in London and the Loughborough College will be concentrating entirely on advanced work. All the colleges have been actively promoting new advanced courses, especially sandwich courses, and large-scale building developments are in progress at Salford and Birmingham, while plans for new buildings are being urgently prepared at Bradford, Cardiff and Loughborough.

Work on the National Institute for Nuclear Science

IN a written answer to a question in the House of Commons on July 30 regarding the National Institute for Nuclear Science, the Prime Minister said that the first task of the Institute has been to examine the proposals for the construction of a new particle accelerator. The design of this machine, a 7,000 MeV. proton synchrotron, which is expected to cost about £7 million, has now been agreed, and its construction, on a site adjacent to the Atomic Energy Research Establishment, Harwell, has been put in hand.

Nigerian Cotton

THE progress reports from experiment stations in Northern Nigeria for 1955–56 (pp. 25. London: Empire Cotton Growing Corporation, 1957. 9*d*.) record a commercial crop of 152,000 bales of 400-lb. cotton, the second largest ever recorded, although an even larger crop had been expected. This relative deficiency is attributed to excessive rainfall in three provinces in August and September, followed by an early and unusually abrupt onset of the completely rainless and cold weather, with extremely low humidities, of the Northern Nigerian winter. The general incidence of insect pests at Samaru did not appear notably higher than usual, but there is evidence that considerable loss of crop occurred from that cause, and this may also apply to the commercial crop, although at Kontagora and Mokwa damage was far heavier and a severe local outbreak of pink bollworm in northern Katsina also resulted in notable damage. Bacterial blight (*Xanthomonas malvacearum*) was not conspicuously more in evidence but may have done rather more damage, and over the greater part of the cotton belt the weather was such that failure to follow the rules of good cultivation probably incurred a heavier penalty than usual. In seed dressing trials with Agrosan *GN5* against bacterial blight, the protection given to the plants was reflected in the seed cotton yields, but in a spraying trial with 2 lb. DDT and 0·6 lb. gamma-BHC per acre at fortnightly intervals, although a 500 per cent increase in yield was obtained there was no significant difference in yield from different spacings, and last season's tentative conclusion that close spacing results in substantially higher yields was not confirmed at Kontagora. *Diperopsis watersi* was the most damaging bollworm at Samaru, but the highest incidence occurred at Kontagora. Together with pink bollworm, both false codling moth (*Argyroploce leucotreta* Meyr.) and spiny bollworm (*Earias* sp.) are assuming greater importance with the southerly extension of the main cotton-growing areas.

Ergot in Gramineae

THE well-known ergot disease (*Claviceps purpurea*) occurs on many grass species, including important cereal and forage crops. Further studies of the pathogenicity of this fungus have now been described by W. P. Campbell (*Canadian J. Bot.*, 35, 315; 1957). Four hundred and twenty-one isolates of *Claviceps purpurea* from thirty-eight different host species were cultured on an artificial medium. The conidial cultures were used for inoculating rye, wheat and barley growing in the greenhouse. All cultures, except one from *Glyceria borealis*, infected the three host species. Honeydew from rye was used for inoculating forty-six gramineous species in the field and in the greenhouse. Every one of these grasses became infected in both locations. The author has shown that all indigenous and forage grasses constitute a reservoir of ergot inoculum for rye, wheat and barley, and that these cereals can be infected provided the environmental conditions are such that inoculum will be disseminated at the time that the cereal crops are in blossom.

Medical Research Council Travelling Awards

THE Medical Research Council announces that it has made the following travelling awards for the academic year 1957–58. *Rockefeller Travelling Fellowships in Medicine:* Dr. J. Butler, senior registrar, Medical Professorial Unit, Queen Elizabeth Hospital, Birmingham; Dr. W. I. Cranston, assistant to the regius professor of medicine, University of Oxford; Dr. D. A. Heath, lecturer in pathology, University of Birmingham; Dr. F. P. Muldowney, University tutor in medicine, St. Vincent's Hospital, Dublin; Dr. W. L. Nicholas, lecturer in zoology, University of Liverpool; Dr. G. R. Webster, senior lecturer, Department of Chemical Pathology, Guy's Hospital Medical School. *Lederle Travelling Fellowship in Medicine:* Dr. A. M. Dawson, registrar, Department of Medicine, Postgraduate Medical School, London. *Dorothy Temple Cross Research Fellowship in Tuberculosis:* Dr. H. P. Lambert, registrar, University College Hospital, London. *Alexander Pigott Wernher Memorial Travelling Fellowships in Ophthalmology and Otology:* Dr. R. P. Gannon, medical officer, Royal Air Force, and officer in charge, Royal Air Force Acoustics Laboratory; Dr. D. M. Maurice, Medical Research Council Ophthalmological Research Unit, Institute of Ophthalmology, London; Dr. J. S. Speakman, resident in ophthalmology, Toronto General Hospital, Toronto. *French Exchange Scholarships in Medical Science:* Mr. B. L. Silver, research scholar, University College, London; Dr. Constance E. Work, first assistant, Department of Chemical Pathology, University College Hospital Medical School, London. *Lilly Foreign Fellowships:* The Eli Lilly Company of Indianapolis has also selected the following candidates, nominated by the Medical Research Council, for Lilly Foreign Fellowships

administered by the Company: Dr. L. J. P. Duncan, lecturer in therapeutics, University of Edinburgh; and Dr. R. F. Mahler, lecturer in therapeutics, University of St. Andrews.

Ramsay Memorial Fellowship Awards

The Ramsay Memorial Fellowships Trustees have awarded fellowships in chemistry for 1957–58 as follow: Mr. T. E. Peacock, a general fellowship at the University College of North Staffordshire; a Glasgow fellowship to Mr. J. K. Sutherland at the Imperial College of Science and Technology, London; a Canadian fellowship to Dr. D. McK. Wiles, at the University of Leeds; a Japanese fellowship to Mr. M. Masui, at University College, London; a New Zealand fellowship to Mr. J. E. Fergusson, at University College, London; Spanish fellowships to Mr. P. Arambarri, at Rothamsted Experimental Station, and to Mr. D. Rodriguez, at the University of Sheffield; a Swiss fellowship to Dr. R. Hümbelin, at University College, London. The Trustees have renewed the following fellowships for the same year: Dr. M. J. Stephen (general fellowship), at the University of Cambridge; Dr. G. S. Harris (Glasgow fellowship), at the University of Cambridge; Mr. C. H. Stam (Netherlands fellowship), at the University of Leeds; Dr. J. R. Villanueva (Spanish fellowship), at the University of Cambridge.

Conference on Industrial Carbon and Graphite

The Society of Chemical Industry is to hold a three-day Conference on "Industrial Carbon and Graphite" at the William Beveridge Hall, University of London, W.C.1, during September 24–26. Many countries, including the United States, the U.S.S.R., France and the Netherlands, will be represented, and more than fifty papers have been submitted. Carbon and graphite provide a wide and important field of study, especially in nuclear energy and electrical applications. Papers will be preprinted, and summarized at the Conference in selected groups, to enable the fullest discussion to be held during the Conference. Prior registration for membership of the Conference is necessary (£4 for non-members of the Society of Chemical Industry); application forms can be obtained from the Assistant Secretary, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1, or from the Hon. Secretary of the Conference Committee, E. A. Smith, Acheson Industries (Europe), Ltd., 18 Pall Mall, London, S.W.1. Members of the Conference will receive preprints of all the papers. An exhibition of carbon and graphite will be held in the Department of Chemical Engineering, University College, Gower Street, London, W.C.1, during the Conference.

University News: London

The following appointments in the University of London are announced: Dr. S. D. Elek, reader in bacteriology at St. George's Hospital Medical School, to the chair of bacteriology tenable at that School; Dr. F. R. Johnson, lecturer in anatomy in the University of Sheffield, to the readership in anatomy tenable at the London Hospital Medical College; Dr. P. H. Spencer-Silver, to the readership in anatomy tenable at Middlesex Hospital Medical School. The title of reader in the University of London has been conferred on: Dr. J. B. E. Baker (pharmacology) in respect of his post at Charing Cross Hospital Medical School; Mr. E. A. Gellner (sociology) in respect of his post at the London School of Economics and Political Science; Dr. T. W. Glenister (anatomy) in respect of his post at Charing Cross Hospital Medical School; Miss D. M. Hall (chemistry) in respect of her post at Bedford College.

Announcements

Prof. Arthur Holmes, emeritus professor of geology in the University of Edinburgh, has been awarded the Paul Fourmarier Prize for 1947–56 of the Royal Academy of Belgium.

Mr. G. H. Hinds, electronics advisory officer, British Transport Commission, has been appointed (at the nomination of the Royal Society) a member of the General Board of the National Physical Laboratory. Mr. Hinds is also to serve on the Advisory Committee on High Speed Calculating Machines, Department of Scientific and Industrial Research.

The U.S. National Science Foundation has announced that its publications are available to all scientists who need them. Lists of publications are available from the Foundation; requests should be addressed to the Publications Office, National Science Foundation, Washington 25, D.C.

Reference was made in *Nature* of August 3, p. 218, to the translation service being organized by the British Iron and Steel Research Association and the Iron and Steel Institute. Inquiries in connexion with this service should be sent to the Institute, 4 Grosvenor Gardens, London, S.W.1.

The International Association of Microbiological Societies has at its disposal certain limited funds, which it receives from the International Union of Biological Sciences, for assisting the work of type culture collections of micro-organisms. Curators of such collections who make their type cultures internationally available and require financial help for this purpose are invited to make application, specifying their need, to the secretary of the International Association of Microbiological Societies, Prof. G. Penso, Istituto Superiore di Sanità, Vialo Regina Elena 299, Rome.

The committee of the Oliver Memorial Fund is to make its annual award of £50 to a British subject whose original work or services in connexion with blood transfusion is considered to be a notable contribution to the research, organization or donor aspects of that subject. Applications and communications directing attention to suitable candidates must be submitted before September 30 to the honorary secretary, Mrs. F. E. Bedborough, 105 New Park Avenue, London, N.13, to whom all inquiries should be addressed.

The annual congress of the British Veterinary Association is to be held at Cambridge during August 25–31. All inquiries should be addressed to the Association at 7 Mansfield Street, Portland Place, London, W.1.

Erratum. In the communication "Amino-Acid Sequence of the α-Melanocyte-stimulating Hormone" by Dr. J. Ieuan Harris and Dr. Aaron B. Lerner in *Nature* of June 29, p. 1346, parts of the sequence indicated on p. 1347, col. 1, have been displaced. The vertical arrows pointing downward should be between 2 and 3, 7 and 8, and 9 and 10 respectively; the lower arrow pointing upwards should be between Arg. and Try.

FLOUR AND BREAD

THE 110th meeting of the Nutrition Society was held during July 5–6 in the Anatomy School, Cambridge. It took the form of a symposium on "Flour and Bread". In his introductory remarks the chairman, Sir Rudolph Peters, expressed the hope that the symposium would lead to a better appreciation of the essential facts on bread and flour and that discussion would be free from bias.

Dame Harriette Chick then summarized the fascinating history of wheat cultivation and bread-making from antiquity onwards, emphasizing that until comparatively recent times white bread was generally desired, being a sign of wealth and refinement. The unconventional, however, have always attributed health-giving virtues to the darker bread of the country folk, though there could formerly have been no informed arguments in support of this opinion, and the darkness of the country bread was due no less to inclusion of rye, barley, or even legumes, than to the use of meal of higher extraction. Furthermore, the refined flours from stone-milling must have contained more germ and aleurone layer than modern roller-milled white flour; the latter by the end of the nineteenth century was the common food of the British people.

Earlier scientific work on flour dealt with chemical and physical properties of its proteins—particularly of the gluten because of its importance in baking technology. From the middle of the past century, however, the nutritive value of the different parts of the grain has been studied. Dame Harriette emphasized the merits of the work during 1883–84 of Rubner and of Girard, particularly in showing the high protein content of the aleurone layer which in milling is separated with the bran. Later workers have shown that 80–90 per cent of this protein is available to human subjects. The proteins in wheat bran are richer than those of white flour in two of the essential amino-acids, namely, lysine and tryptophan, which is why animal-feeding experiments have shown that the value of white-flour protein is increased by the presence of a little bran.

The uneven distribution, in the grain, of essential nutrients other than protein was discovered about the period of the First World War. After recalling the pioneer researches on the cause of beriberi among rice-eaters, Dame Harriette mentioned that this disease, which at the time was puzzling the authorities, was diagnosed among Commonwealth troops on Lemnos by Col. C. J. Martin, at that time director of the Lister Institute; their diet had mainly been white bread and tinned meat. This led to the finding that the anti-beriberi factor was concentrated in the germ of both wheat and rice. The specification for 85 per cent National flour, recommended by the Accessory Food Factors Committee of the Lister Institute and the Medical Research Council, was a satisfactory compromise in that, while the nutritive value of the flour approached that of a 100 per cent meal, its fibre content was nearer to that of white flour. Research at the Research Association of British Flour-Millers had shown that the detail of this recommendation could be achieved in practice.

Dr. C. R. Jones used a simplified flow-sheet to explain the essentials of the flour-milling process and discussed the differences in nutrient content between the various flour streams that together form the straight-run flour. The compositions of these streams at different extraction-rates were shown. Vitamin B_1, in particular, is largely contained in a small proportion of the total flour from the end of the milling system, which incidentally is of poor bread-making quality. Data were given in illustration of the point that, even at a given extraction-rate, the 'natural' contents of nutrients in straight-run flour may vary considerably.

In a discussion that clearly greatly entertained her audience, Miss E. M. Widdowson considered some of the factors affecting the planning of human nutritional experiments and the difficulties encountered. She stressed that, in the first instance, it is well worth while to plan the perfect experiment, and then see how nearly the design can be put into practice. While avowing that the investigator should include himself among the experimental subjects, Dr. Widdowson remarked that any sort of nutritional experiment is bound to curtail one's social activities. Thus, the balance experiments in connexion with the effects of phytic acid in brown flour on calcium absorption lasted for nearly a year, with only one week-end free every four weeks. Particular difficulties encountered in the celebrated German experiments included the overcoming of a belief by those in charge of one home that it was morally wrong to allow children to eat *ad lib.* In one orphanage, where bread was given in addition to the inadequate German rations, the children grew less well than a similar group in another orphanage where no extra food was given. The reason was ascribed to the unsympathetic personality of the woman in charge of the first group; the children actually ate the extra food but failed to benefit from it.

Subsequent discussion showed that this last observation had created much interest. Mr. A. L. Bacharach inquired whether any data showing the effects of emotional disturbance had been obtained from animal feeding trials. Prof. R. A. McCance reminded the meeting that the secretions of the thyroid and pituitary glands may be affected by 'nerves'. Points made by other speakers were that a negative nitrogen balance is associated with emotional disturbance and that hospital experience shows that anxiety causes increased excretion of fat. Both the chairman and Dame Harriette refuted any suggestion that animal experiments are without significance in human nutrition by recalling signal discoveries made originally by means of experiments on animals.

Dr. Neil Jenkins, referring to the absence of evidence in support of the belief that high carbohydrate consumption promotes dental decay, and that brown bread is better than white in this respect, offered the following two suggestions. Flour, or bread, texture may be important; the extent to which food debris adheres to teeth is less after eating brown than after eating white bread. He also recalled T. B. Osborne's postulate that bran contains a factor that hinders attack on teeth by acids. Jenkins suggested this may be a phytate, since he has found that phytates reduce the rate at which

calcium in extracted teeth will dissolve in acid media.

Prof. R. A. Morton recalled the formation of the Panel on Composition and Nutritive Value of Flour under the chairmanship of Sir Henry Cohen (now Lord Cohen of Birkenhead), of which he was a member, and gave a most interesting account of its considerations and conclusions. He stressed the consideration that while the adoption of an 80 per cent flour might conceivably ensure against possible but as yet unknown shortages in the diet, the enrichment of white flour would give more positive protection against clearly defined deficiency states. He personally was impressed by the hazy nature of the current assessment of requirements of several nutrients, especially in view of the possible occurrence of side-reactions.

Dr. H. M. Sinclair pointed out that flour, or bread, is the most important single item of diet in Britain. In 1947, 85 per cent extraction flour provided 27 per cent of calories consumed, 37 per cent of protein and about the same proportion of requirements of B_1, iron, phosphorus and nicotinic acid. Of the nutrients excluded from the present enrichment scheme, he considered that riboflavin was more important than was recognized by the Post-War Loaf Conference. As a single source of supply of riboflavin, bread is more important even than milk. He suggested that, if we must have white flour, riboflavin should be included in the enrichment policy, as in the United States and Canada.

As to whether, in other respects, enriched 70 per cent is equivalent to high-extraction flour, a table was presented showing that the contents of pyridoxin, biotin, folic acid, linoleic acid and vitamin E (α-tocopherol) were all materially lower in the white flour; only in the case of pantothenic acid was there no appreciable difference. In Dr. Sinclair's opinion, pyridoxin, linoleic acid and vitamin E have been grossly neglected and are very important in human nutrition. High-extraction flour is the most important single source of pyridoxin; but a decreased extraction-rate causes a serious reduction in our intake. On the other hand, judging from recently reported work with monkeys, human requirements may be met only to the extent of about one-third, even with 80 per cent extraction flour.

Dr. Sinclair tentatively estimates the contents of linoleic acid in 80 per cent and in 72 per cent flour as 0·8 and 0·5 per cent, respectively. Normally it is protected, both from atmospheric oxidation, and during body metabolism, by its accompanying vitamin E. The consideration may therefore be important that not only is vitamin E present initially to a smaller extent in white flour but also it is in any event destroyed by bleaching. Moreover, bleaching may not only destroy the essential-fatty-acid activity of the linoleic acid in flour but also may convert this substance into an antagonist that might increase the essential-fatty-acid requirement. Essential-fatty-acid deficiency might arise from dietary deficiencies in respect of linoleic acid, or of pyridoxin, or of vitamin E, since these are functionally interrelated, and in Dr. Sinclair's view it may be relevant to a variety of diseases of civilization, including coronary thrombosis and dental caries.

Dr. D. W. Kent-Jones, in presenting "The Case for Fortified White Flour", stressed the importance of the preference of the British public for white bread as against even the slightly darker 80 per cent extraction flour. It must also be remembered that destruction of certain nutrients occurs in cooking and baking, and only 65 per cent of all flour milled is made into bread; the rest is used for cakes, biscuits, home cooking, etc. The respective merits of breads made from long extraction and from enriched white flours had been comprehensively considered by the Cohen Committee, which took into account the Widdowson–McCance Report on the German experiments that may well be regarded as decisive. Nevertheless, the levels of fortification originally suggested by the Post-War Loaf Conference are now under re-examination by the Food Standards Committee, which is also considering whether fortification with riboflavin should be carried out. In presenting revised values for the contents of various B vitamins in flours of different extractions, Dr. Kent-Jones pointed out that lower-extraction flours are by no means devoid of the rarer components of the B complex; he also stressed that we know little of the actual daily requirements of most of them. He emphasized the importance of the Newfoundland experiment on the effects of white flour, enriched on the American scale, and of enriched margarine. This lasted more than four years, three hundred subjects being carefully examined before and after the experiment, during which visible signs of malnutrition, and also various mortality-rates, decreased. Moreover, quoting Wilder, "the quality of life had improved in Newfoundland". Dr. Kent-Jones also stressed that, in baking, half the vitamin E is destroyed, and in any event, cereals do not contribute much vitamin E to the diet.

A paper by J. R. Nicholls and J. R. Frazer, which was read by Dr. Nicholls, discussed analytical problems in the determination and control of extraction-rates of flour. Although extraction-rate is not an absolute yardstick for defining the grade of a flour, the term is widely used in industry and generally understood. The basic difficulty in its determination, by analysis of a sample, is that although 100 per cent extraction flour contains the whole of the bran, flours of lower extraction contain only selected fractions of the bran layers, which may differ in chemical composition from whole bran.

The authors reviewed various chemical constituents of flour and wheat and showed that none is strictly applicable to the determination of extraction-rate. The only practical course is to judge analytical values obtained on a given sample against corresponding data accumulated from an extensive survey of samples, having regard to the coefficient of variation found for each value. There is, however, a particular interest attached to the determination of starch, since this is provided practically entirely by the endosperm, while other carbohydrates are distributed to varying extents throughout the grain. The starch content of the endosperm is affected by the protein content, which varies considerably between wheats, but the ratio of non-starch carbohydrate to the sum of starch plus protein was offered as an approximate index of flour grade. Values for this index appeared characteristically dependent on extraction-rate and fairly independent of type of grist.

In opening the final discussion, the chairman acknowledged the differences in points of view and even in basic data offered by the several contributors, but hoped that these would be subjected to further scientific examination. Regarding the German

experiment by Widdowson and McCance, he emphasized the possible significance of the soup supplied to the children as a source of important nutrients.

Dr. B. S. Platt challenged Dr. Kent-Jones's conclusion from the Newfoundland experiment that, in view of the health improvement found, high-extraction flour could have contributed no more than the enriched white flour actually used. The Wilder report had stated "not all the outward signs of malnutrition had decreased in prevalence. Only those had lessened which could have been affected by addition of vitamin A to margarine and of riboflavin, niacin and thiamine (B_1) to the flour". In replying, Dr. Kent-Jones interpreted Wilder as attributing the persistent signs to vitamin C deficiency, not to deficiencies for which the flour could have been held responsible.

Dr. E. Kodicek emphasized that a proportion of nicotinic acid in cereals is in the bound form and unavailable to a number of animals. On the other hand, nicotinic acid added by way of enrichment is wholly available.

Several contributors queried the claim that the public strongly preferred bread made from white flour to that from higher-extraction flour. In this connexion, Dr. J. B. M. Coppock referred to published evidence in support of the claim which had been obtained in a comprehensive survey on consumer preference recently carried out in Glasgow.

The relevance or otherwise of mortality statistics in relation to modern food habits and processing techniques was discussed both by Prof. J. J. Yudkin and Dr. Sinclair. The meeting ended appropriately with a plea by Mr. Bacharach for liberty of choice: members, he said, are free to express views but should not seek to force their adoption.

C. R. Jones

INSTITUTE OF BIOLOGY CONVERSAZIONE

THE annual conversazione of the Institute of Biology, London Branch, was held at the Imperial College of Science and Technology on the evening of June 25. Members and their guests were received in the Students' Union by Prof. P. H. Gregory (head of the Botany Department), F. Howarth (assistant director of the Botanical Laboratories) and Dr. H. O. J. Collier (chairman of the London Branch). A diversity of exhibits was displayed in the Botany Department, by courtesy of Prof. Gregory.

The word 'conversazione' has an Italian derivation and can be defined as a meeting of people for conversation and discussion, particularly on literary, scientific, antiquarian or artistic subjects. The emphasis is, therefore, on the facilities for social intercourse: these were admirably provided in the newly built Students' Union. To say that exhibits take second place to discussion at such a function is not to detract from their importance, for they themselves are the chief topics of conversation.

The Linnean Society of London, this year's guest society, provided an exhibit illustrating the evolution of the "Species Plantarum" by means of books and manuscripts, as well as items from Linnaeus's natural history collection, including insects, shells and plants. In addition, some of his own annotated works were exhibited and a map of the world showing journeys undertaken by his students to make collections. This was appropriate in the year of the 250th anniversary of the birth of Carl Linné, and provided an interesting comparison with 'Huxleyana', an exhibit showing some of the work of T. H. Huxley and presented by the Zoology Department of the Imperial College.

Each year the London Branch invites one firm of biological suppliers to provide a trade-stand, which, this year, was devoted to stains and reagents for microscopy, modern mounting media, water analysis tablets for field ecology and so on, presented by Edward Gurr, Ltd. Specimen publications were displayed by the Universities Federation for Animal Welfare, the quarterly journal *Medical and Biological Illustration* and the Institute of Biology. The London Branch's own exhibits included photographs taken during a week-end excursion to the Severn Wildfowl Trust and new trends in biological education.

It is not easy to decide which of the forty or more members' and guests' exhibits most deserve mention. Certainly one of the most original was a 'self-reproducing analogue' (Prof. L. S. Penrose and R. Penrose) recently described in *Nature* (179, 1183; 1957). Various suitably shaped wooden or plastic objects, when shaken in a trough, generate precise copies of themselves. The process has been termed pseudo-biosynthetics.

Living animals always attract interest and were a feature of several exhibits. In one (P. Hunter-Jones) normal hoppers and adults of the desert locust (*Schistocerca gregaria*), reared either in crowded conditions or in isolation—phases *gregaria* or *solitaria*—were compared with albino strains raised under similar conditions. In another (A. T. Thompson) could be seen representatives of some of the exotic grasshoppers kept at the Anti-Locust Research Centre. Cultures were shown of Pharaoh's ant (*Monomorium pharaonis*) (A. A. Green) and of the American damp-wood termite *Zootermopsis angusticollis* (W. V. Harris and R. M. C. Williams). This insect provides a useful laboratory source of large protozoa, especially species of the genus *Trichonympha*.

Insects also appeared in exhibits of important species of tsetse fly with distribution maps and colour transparencies of their breeding habitats (Dr. J. R. Busvine), the biology of a British 'ambrosia beetle' (J. M. Baker), the use of 'Terylene' netting for studying the pattern of emergence and decay in a wheat bulb-fly population (J. W. Stephenson and R. W. Dobson) and in preparations of the genitalia of certain beetles (L. P. Lefkovitch). The effect of gamma-rays on ovarian development in the tsetse fly, *Glossina morsitans*, was illustrated by slides showing the ovaries of a 33-day-old female from an irradiated pupa, which were less developed than those of a 3-day-old female from a normal pupa (W. H. Potts).

In the fields of microbiology were exhibits of membrane filter techniques for concentrating and counting micro-organisms and new selective culture media (W. H. Pierce), some superb photographs of mammalian gametes (Dr. M. W. H. Bishop and Dr. C. R. Austin), preparations showing the cell structure of Cyanophyceae (Dr. J. K. Spearing), an antibody to *Trypanosoma vivax* present in normal cotton rat serum (Dr. R. J. Terry and Miss V. M. Smith), and tests for the antibiotic sensitivity of bacteria (W. A. Freeman).

Immunological exhibits also included the effect of insects in causing allergic symptoms in human beings (Dr. A. W. Frankland), a survey of the fungal spore and pollen content of the air (Miss E. D. Hamilton), immunology in agar cells (Dr. J. G. Feinberg, Dr. R. A. Grant and Miss H. Grayson), and gel diffusion methods for immunological assay (Miss B. J. Hayward).

The traditional use of dock leaves to allay the pain of nettle stings has led to the search for an antagonist of 5-hydroxytryptamine in dock-leaf extracts. The presence of such an antagonist and its action was demonstrated on *in vitro* preparations of smooth muscle (R. J. Brittain and Dr. H. O. J. Collier). The effect of drugs on the movements of the pig roundworm (*Ascaris* sp.) was recorded by means of a kymograph technique (Dr. L. G. Goodwin). The apparatus section included a light-scattering photometer (Dr. A. B. Taylor), a device for rapidly collecting samples of insects such as bees (L. Bailey), and apparatus for testing soil and plant tissue for mineral deficiencies (Dr. G. P. L. Miles).

Visitors were able to test their taste-threshold to phenylthiourea, which depends upon a single autosomal gene (Dr. H. Kalmus). The present writer, like one of his children, was unable to detect any flavour even in the strongest solution provided; his wife could distinguish something, but his other two children responded violently and vulgarly to its bitter taste. In contrast, all members of the family were able to appreciate the delicious home-made wine which formed an exhibit in the hobbies section (H. W. Appleton).

The hobbies of professional biologists are by no means without interest, but have not previously been represented in a London Branch Conversazione. The series of colour photographs of British orchids (J. H. P. Sankey), oil paintings (Dr. J. R. Busvine), drawings of caddis-flies (Dr. N. E. Hicken) and of flowers (Miss D. Potts), in particular, reached a high standard of artistry. Nevertheless, it is by the standard of the biological exhibits that the Conversazione should be judged. Throughout, they showed imagination and skill.

J. L. Cloudsley-Thompson

WORLD HEALTH ORGANIZATION

REPORT FOR 1956

In his annual report on the work of the World Health Organization for 1956*, Dr. M. G. Candau, the director-general, reviews the beneficent work of the Organization during the past few years and discusses plans for the future.

Considering malaria first, he recalls the recommendation made by the eighth World Health Assembly, held in Mexico, that eradication of malaria, not its mere control, should be the aim, and that an expert committee, which met after the conference of malariologists held in June 1956, drew up a realistic guide for the planning and carrying out of programmes of eradication of the disease. This policy of eradication was adopted because, in addition to long-range economic considerations, the *Anopheles* mosquitoes which are the vectors of malaria became resistant to the insecticides used for their control. Research, which must always back up field work, has shown that, in some instances, mosquitoes resistant to DDT can be controlled by insecticides of the benzene hexachloride type, but that, in some parts of Greece, the mosquitoes are resistant to both these groups of insecticides and, wherever this occurs, other methods of control have to be devised. Preliminary studies promoted by the World Health Organization have shown that the distribution to peoples of salt-containing antimalarial drugs has given encouraging results. Two other antimalarial problems under investigation, both of them important in Africa, are the sorption of insecticides by the mud walls of houses, and the behaviour of the chief vector of malaria in Africa, *Anopheles gambiae*.

The section of the report devoted to malaria is especially interesting because it is illustrated not only by photographs of antimalarial work in Iraq and Mexico, but also by four valuable maps, which show at a glance the distribution of antimalarial activities in Europe, Africa, Asia and North and South America and the progress to date, so far as the latest information permits, of control and eradication programmes. These maps show, for example, that eradication is practically or fully achieved in the western United States and the Californian region, in Puerto Rico, Northern Chile, French Guiana, parts of Venezuela and British Guiana, in the greater part of Ceylon and, in Europe, in Italy, Corsica, Sardinia, Cyprus and Crete. Elsewhere the vigorous campaigns assisted by the World Health Organization are likely, in due course, to rid the world of a disease which is still one of the major menaces to mankind.

This cannot be done, however, without the research work which is, the director-general rightly insists, "the real backbone through which the Organization is striving to promote World Health". It is also a basic function of the World Health Organization to pool all available scientific and technical knowledge, to appraise this knowledge constantly and to study how best it can be applied to problems of public health wherever they occur. Malaria is not by any means the only disease transmitted by insect vectors, and the general problem of the resistance of vectors of disease to insecticides has been tackled by a survey of research. Experts appointed by the World Health Organization have visited more than one hundred laboratories concerned with this problem and the gaps in our knowledge have been defined. Co-ordination of the work of several scientific institutes has developed basic methods of measuring the susceptibility or resistance of vector populations—for example, the lice of man—with the result that the World Health Organization is now able to advise the best method of control, and there has in consequence been a betterment of the control of typhus fever, which is transmitted by lice.

In a different field of work a series of projects initiated by the World Health Organization and its experts has greatly advanced the control of rabies. The efficacy of hyperimmune serum has been demonstrated, and field trials in Iraq on the use of serum in persons exposed to rabies, in Spain on the local treatment of wounds inflicted by animals suffering from rabies, in Malaya and Israel on new vaccines for the control of rabies in animals, and in France and the United States on the standardization of the potency of vaccines and sera, have all contributed

* Official Records of the World Health Organization No. 75: The Work of WHO 1956—Annual Report of the Director General to the World Health Assembly and to the United Nations. Pp. xi+233+16 pages of photographs. (Geneva: World Health Organization; London: H.M. Stationery Office, 1957.) 6 Swiss francs; 10s.; 2 dollars.

much to the control of this disease. An important recent step has been the institution of an international standard serum and a reference vaccine.

This is part of one basic task of the World Health Organization, that of providing medical science with units of measurement, a task which involves much intensive research, under the guidance of expert committees, in laboratories all over the world. Wherever vaccines are concerned, strictly controlled field trials are needed to relate the results of tests made on animals to those expected in man, and work of this kind has shown, as a result of a long series of studies, undertaken by the World Health Organization during 1952–56, that a dry smallpox vaccine can be prepared, which is stable at 45° C. for two years at least. This dry vaccine should improve the control of smallpox in hot countries, and an international reference standard for it is now being prepared.

Among other subjects discussed by the director-general are the psychobiological development of children and endemic goitre. For the treatment of goitre it has been found that iodates are more effective than iodides, and that sodium iodate has a very low toxicity. The World Health Organization therefore appointed experts to assist countries in Latin America in the production of iodized salt for their peoples.

Another aspect of the work of the Organization is concerned with the work of international centres or laboratories which exist for the study of influenza, poliomyelitis, treponematoses, leptospirosis, brucellosis and other bacterial and virus diseases, as well as for biological standardization and blood-grouping. The study of poliomyelitis has shown that, in countries with a high incidence of the paralytic form of this disease, the use of a vaccine is an effective method of reducing its serious effects. Prospects for the control of leprosy have been improved by the discovery of the sulphone drugs, and recent reports confirm that BCG vaccination has a real effect in reducing the incidence of tuberculosis, although, to control the disease, this must be combined with case-finding and treatment.

The director-general emphasizes that, in all work on communicable diseases, thorough and comprehensive planning is necessary. The application of a new method of control, or the adaptation of an established technique, needs careful pilot studies if success is to be ensured. It is realized, too, that technical knowledge and methods are not enough; success will depend on administration, training of personnel, sound technical application and financial support. The organization of public health services is being governed increasingly by the concept of integrated services, rather than by that of services separately provided for specific, limited fields. These integrated services are, for example, being applied in nutrition, maternal and child health and in health education.

More recently the Organization has been concerned with atomic energy in relation to health. The aspects of this general problem being studied are training, the collection and distribution of information on the medical problems that arise and on the medical uses of radioisotopes, the study of health problems arising from the disposal of radioactive waste, international work on the distribution of radiation standards and, related to these, on codes of practice and specifications for the preparation of radioisotopes for medical use, and the stimulation and co-ordination of research on the health aspects of radiation.

An important part of the report describes the work being done in each of the six regions into which the World Health Organization divides the world. There is a detailed list of the numerous projects in operation during the year, and the human aspect of all this work is shown by the excellent photographs selected from typical projects in many parts of the world. To some readers these photographs will tell, more graphically than words can, how widespread, effective and beneficent is the work of the Organization.

G. LAPAGE

INSTRUMENTS FOR MICRO-METEOROLOGICAL MEASUREMENTS

FOR measuring the variations of temperature, humidity, and wind speed near the ground and in growing crops special apparatus is necessary. The spatial rates of change are large compared with those at the height of 4 ft. at which the ordinary screen readings are taken, and on this account specially small apparatus is necessary. Much work has been done on this subject in recent years at Rothamsted Agricultural Experimental Station, and Mr. H. F. Long has recently described the apparatus devised and its properties (*Quart. J. Roy. Meteor. Soc.*, **83**, 202; 1957).

Temperature measurements are made with small resistance thermometers of either the thermistor or nickel wire type. The latter are more stable for purposes of continuous recording. The nickel wire elements used for measuring dry- and wet-bulb temperatures and in the 'hot bulb' anemometer were wound on plastic bobbins 1 mm. in diameter, 3 mm. total diameter with the wire, and 10 mm. long. Still smaller elements 0·8 mm. in total diameter and 5 mm. long were made for measuring the temperature of potato leaves by fitting them into holes made in the leaves with a hypodermic syringe. The elements used for measuring air temperature were protected from radiation by small half-cylinders of copper gauze painted white.

The fact that, at about 10° C. in air which is not too dry, the dew-point is roughly the mean of the dry- and wet-bulb temperatures is used by suitable circuit arrangements for obtaining a rough record of dew-point. Two such sets at different heights balanced against each other give a very sensitive measure of dew-point differences and also enable the times of dew formation, of particular importance to the Rothamsted workers in connexion with fungus disease of potatoes, to be determined very accurately.

For measuring wind speed in the range 0–70 cm./sec. a 'hot bulb' anemometer is used. This has two nickel wire resistance thermometers, one of which is heated by an electric heater. Cooling by the wind tends to equalize the temperatures of the heated and unheated bulbs, and the out-of-balance current in the central galvanometer of a Wheatstone bridge containing the two elements gives a measure of wind speed. Full details of the construction of the instruments and their calibration and degree of accuracy are given in the article. The instruments might well have applications in industrial processes in which accurate readings of temperature, humidity, and air flow are needed.

RATE OF ENTRY OF RADIOACTIVE STRONTIUM INTO PLANTS FROM SOIL

By Dr. R. SCOTT RUSSELL and G. M. MILBOURN

Agricultural Research Council Radiobiological Laboratory, Compton, Nr. Newbury, Berks

PART of the strontium-90 which descends to the Earth's surface in fall-out from nuclear test explosions will lodge on the foliage of plants, part will enter the soil. The relative magnitude of these fractions may vary widely, depending on the nature of the vegetation cover and the rainfall; but it appears that the greater part of the deposition will find its way into the soil. Knowledge of its fate therein is therefore vital if the consequences of fall-out are to be fully assessed. From the practical point of view it is particularly important to determine the fraction of the strontium-90 which is likely to be absorbed by crops in each successive season, and the ratio of strontium-90 to calcium which will occur in them. The close relationship between the metabolism of strontium and calcium in animals indicates the importance of the latter question.

The rate of absorption of strontium-90 will depend on the character of the soil, the climate and the vegetation. Thus the study of this subject on an adequate scale presents obvious difficulties. Two methods of investigation are possible—the survey of current fall-out and tracer experiments. The survey procedure has the attraction that the behaviour of actual fall-out is observed, but quantitative data are difficult to obtain since all herbage is likely to be contaminated to some extent by direct aerial deposition as well as by absorption from the soil. Furthermore, the problems associated with measuring the very low levels of strontium-90 which have been so far deposited demand elaborate techniques. Tracer experiments by contrast provide a simple and precise method for ascertaining the fraction of a given application of radioactive strontium which enters plants. Since it is known that long-range fall-out is relatively soluble, such experiments should provide a realistic basis for assessment provided that: (*a*) the tracer is applied to the surface of the soil in a soluble carrier-free form in much the same manner as if it were washed down by rain; (*b*) experiments are carried out under field conditions, thus avoiding abnormalities in root distribution such as may occur in pot or greenhouse experiments.

Experiments of this type should provide information on situations which would occur in the worst case, namely, if all the fall-out strontium were freely soluble. The absorption by plants would be less if part of the deposition were contained in sparingly soluble particles; prudence, however, indicates the importance of obtaining knowledge of the worst situation which could occur. Such experiments could serve the further purpose of providing information on the extent to which the absorption of fall-out strontium could be modified by altering cultivation practices in an emergency. Field experiments have therefore been undertaken by the Agricultural Research Council Radiobiological Laboratory, Compton, Berks. The short-lived isotope strontium-89 (half-life 54 days) has been used for reasons of safety in preference to the long-lived strontium-90. The first experiment, which is here described, was carried out in 1956 on a chalk downland in Berkshire. The work is now being extended to five representative areas of other soil types in different parts of the country. The Ministry of Agriculture, Fisheries and Food is collaborating in these investigations.

The strontium-89 was applied to the surface of the land in the form of a spray at the rate of 66 μcurie/metre^2. A commercial field sprayer modified in the manner described later enabled this operation to be carried out in safety. The volume of the solution used was equivalent to 100 gallons/acre. It appeared possible that the extent to which the simulated fall-out would enter plant roots might be influenced by whether it fell directly on the ground surface or lodged on plant tissues which were afterwards ploughed into the soil. Accordingly, land carrying stubble at the time of contamination was compared with bare fallow. Three subsequent cultivations were employed—rotary cultivation to the depth of 4 in., normal ploughing to the depth of 7 in., and double ploughing (7 in. followed by 12 in.). In this way it was hoped to obtain the greatest practicable variation in the manner in which the contamination was placed in the seed bed. A single deep ploughing to the depth of 12 in. was not possible with the available equipment because of the hardness of the subsoil, which was within 9 in. of the ground surface. Three crops, rye-grass, sugar-beet and barley, were afterwards planted. The eighteen combinations of conditions of the soil × cultivations × crops were employed in four-fold replication, the plot size being 4 yd. × 8 yd. Half of each plot received lime at the rate of 2 tons per acre. Two cuts of rye-grass were taken; the above-ground parts of the other crops were sampled at the time of harvest.

Complete randomization of the initial condition of the land and the cultivation treatments was impracticable. The consequent restriction on the precision with which treatments could be compared has made it possible to establish the statistical significance of effects only when their magnitude is large.

In the planning and conduct of the experiment the Laboratory enjoyed the close co-operation of the Health Physics Division, Atomic Energy Research Establishment, Harwell. A site remote from buildings or water supplies was selected and surrounded by a chain-link fence. The spraying equipment, which was mounted on a tractor, was modified to enable the boom to be readily removed and decontaminated (Fig. 1). The drift of spray and the exposure of personnel were reduced by the following procedures: employing a boom hood from which a polythene apron reached as near as practicable to the ground surface; using a large droplet size; and spraying head-on into the wind when the wind-speed was less

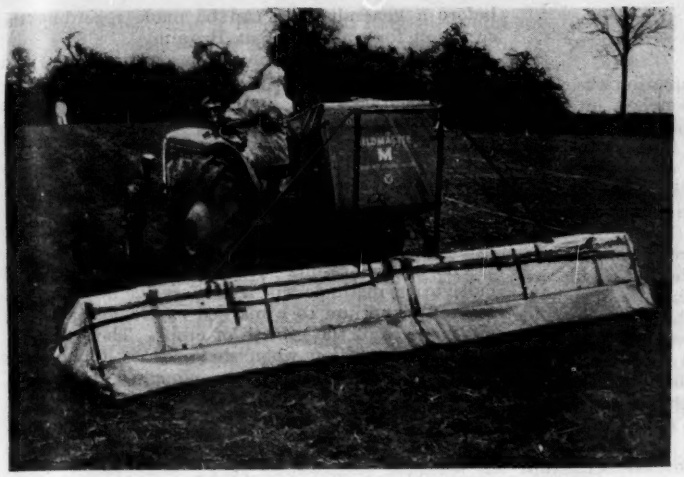


Fig. 1. Spraying equipment for the application of strontium-89 in the field

than 4 m.p.h. Polythene sheeting and strippable paint were employed to facilitate decontamination on both tractor and spray tank. Air samplers were mounted in front of the tractor driver and on a 'Land Rover' which followed the tractor 20 yd. down wind. Polythene protective clothing and respirators were worn by the tractor driver and 'Land Rover' crew. Similar precautions were taken in subsequent cultivations. The highest air-borne contamination was recorded on the 'Land Rover' during spraying but did not exceed one-hundredth of the maximum permissible level for occupational exposure recommended by the International Commission for Radiological Protection. After spraying was complete, the spray boom and hood were sealed in polythene sheeting; the decontamination of other equipment presented no problems. These results imply that a very adequate standard of safety was maintained. In fact, from the experimental point of view, the degree of air-borne contamination was unfortunately low; during the ploughing operation it was below the level at which precise measurements could be made by the sensitive survey instruments employed. Thus no exact calculation was possible of the degree of hazard which would result from the cultivation of land of this type if it were contaminated with a heavy level of fall-out.

Table 1. Absorption of Strontium-89 and the Ratio of Strontium-89 to Calcium for Sugar-Beet, Rye-Grass and Barley

Crop	Yield per acre (cwt.)	Sr-89 content as per cent of dose	Sr-89/Ca ratio (mμc./gm. Ca)
Sugar-beet			
Tops		0·61 ± 0·020	26·6 ± 1·2
Roots	164·0	0·17 ± 0·010	46·5 ± 2·6
Total		0·78	
Rye-grass			
1st cut	18·92	0·390 ± 0·034	43·1 ± 4·1
2nd cut	7·33	0·072 ± 0·005	44·0 ± 1·7
Total	26·25	0·462	
Barley			
Grain	26·0	0·016 ± 0·002	52·6 ± 5·6
Straw		0·106 ± 0·007	54·7 ± 2·7
Total		0·122	
Significant difference between all crop parts	5 per cent	0·067	10·0
	1 ,,	0·091	13·4
	0·1 ,,	0·122	17·7

The salient features of the results are summarized in Tables 1–3. A more detailed discussion will be presented elsewhere. The mean figures for each crop (Table 1) show that crop yields were within the normal agricultural range for the area. The fraction of the strontium-89 which the crops absorbed ranged from 0·12 per cent for barley (grain and straw) to 0·78 per cent in sugar-beet (shoots and storage organs). The strontium-89/calcium ratio was in the same general order for all tissues except in the leaves of sugar-beet, which showed markedly lower values; this observation accords with the findings of other investigators that the strontium-89/calcium ratio is higher in roots than shoots[1,2]. It would be unwarranted to infer from a comparison of the values of the aerial parts of the three species that sugar-beet shows intrinsically different discrimination against strontium; differences in the distribution of roots could cause this effect since the contamination was not uniformly distributed through the soil (Table 3).

Table 2. Summary of Effects of Treatment on all Crops

	Sr-89 content as per cent of dose applied	Sr-89/Ca ratio (mμc./gm. Ca)
Condition of land at time of spraying		
Fallow	0·40	39·3
Stubble	0·50	48·5
		Significant difference 6·8 (5%)
Cultivations		
Rotary cultivation	0·388	38·0
Shallow ploughing	0·526	49·6
Double ploughing	0·442	44·1
		Significant difference 7·1 (5%) 9·5 (1%)
Liming		
Limed	0·444	43·0
Non-limed	0·458	44·6
		No significant difference

Table 3. Percentage Distribution of Strontium-89 in Soil Profile following Cultivation Treatments

	Horizon (in.) 0–4	4–8	8–12
Cultivations			
Rotary cultivation	86·1	8·9	5·0
Shallow ploughing	45·9	50·6	3·4
Double ploughing	70·3	22·4	7·3
Significant difference 18·6 (5 per cent)			

The mean effects of the various experimental treatments on all the crops are summarized in Table 2. No significant effects on the absorption of calcium were induced. Thus the absorption of strontium-89 and the strontium-89/calcium ratio were affected similarly. On the average of all crops the strontium-89 values were 25 per cent greater when the land had been under stubble than in bare fallow at the time of contamination. The extent of the effect varied between crops and was maximum in the first cut of rye-grass when the values for the strontium-89/calcium ratio were:

Fallow	3·17
Stubble	5·45
Significant difference (5 per cent)	1·95

It appears, therefore, that contamination absorbed on herbage which is afterwards ploughed into the soil is more readily available to plants than contamination directly incorporated into the labile cation complex of the soil. This effect would be expected to decrease with time; the fact that no significant difference was observed in the second cut of rye-grass supports this view.

The effects of the cultivation treatment on the distribution of strontium-89 down the soil profile are shown in Table 3. Except in the shallow ploughing treatments more than 70 per cent of the contamination was found in the upper 4 in.; the second ploughing of the double ploughing treatment had apparently returned an appreciable fraction of the contamination to a higher level. Shallow ploughing led to the greatest strontium-89 content in all crops; the maximum effect again occurred in the first cut of rye-grass and the values for the strontium-89/calcium ratio were:

Rotary cultivation	3·15
Shallow ploughing	6·28
Double ploughing	3·50
Significant difference (1 per cent)	3·06

No effect of cultivation was, however, apparent in the second cut.

The present experiments indicate that less than 1 per cent of the strontium-89 was recovered by crops in one year. Under very different conditions of soil and climate, Reitemeier[3] found values ranged from 0·5 to 1·5 per cent for soya-beans and broom-grass. Further results must, however, be awaited before a generalization can be made regarding the situation for soils in Great Britain.

Because of the relationship between calcium and strontium in the absorption process the view has been encouraged that liming will reduce the uptake of strontium-90. The absence of any effect in this experiment, however, agrees with the results of numerous small-scale experiments which indicate that the strontium-90/calcium ratio in plants is likely to be affected by liming to an important extent only in soils which contain inadequate calcium for crop production[2].

The present results suggest that the alteration of cultivation methods will not affect the absorption of fall-out strontium to a marked extent except in the early stages of the growth of crops. The possibility of some mitigation when shallow-rooted plants are grown in soils which can be ploughed deeply in a single operation cannot, however, at present be excluded.

The primary object of this preliminary report is to direct attention to the desirability of obtaining data on as wide a scale as possible. It is to be emphasized, however, that, because of the rapid decay of strontium-89, experiments with this isotope can provide information only on absorption in the year immediately following contamination. There are reasons for believing that the physico-chemical equilibration in the soil may cause the absorption of strontium-90 to decrease with time to a greater extent than would be predicted on the basis of its decay-rate[3]. This can, however, be verified only by experiments with strontium-90, which for reasons of health can be carried out only on a very restricted scale.

[1] Menzel, R. G., and Heald, W. R., *Soil Sci.*, **80**, 287 (1955).
[2] Comar, C. L., Wasserman, R. H., and Scott Russell, R., *Science* (in the press).
[3] Reitemeier, R. F., A.E.R.E./SPAR., 12 (1955).

CORRELATION BETWEEN PHOTONS, IN COHERENT BEAMS OF LIGHT, DETECTED BY A COINCIDENCE COUNTING TECHNIQUE

By R. Q. TWISS and A. G. LITTLE
Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Sydney
AND
R. HANBURY BROWN
University of Manchester Jodrell Bank Experimental Station

THERE has recently been a controversy[1–4] in the columns of *Nature* on the existence of a correlation between photons in coherent beams of light. In the initial communication[1], by Hanbury Brown and Twiss, an experiment was described in which light from a pinhole source was split, by a semi-transparent mirror, into two separate beams which then illuminated the cathodes of two separate phototubes. As long as the two light beams were partially coherent a correlation was observed between the fluctuations in the anode currents of the two phototubes and it was argued that this proved that the arrival times of light quanta at different points illuminated by coherent beams of light were correlated.

This experiment was criticized by Brannen and Ferguson[2], who had themselves carried out a somewhat different test, in which the simultaneous emission of photoelectrons at the two photocathodes were recorded by a coincidence counter, and in which no significant difference was observed in the number of counts with coherent or incoherent light. Furthermore, these authors suggested that the results obtained by Hanbury Brown and Twiss were due, not to a true correlation between the arrival times of quanta, but to some other cause such as an intensity fluctuation in the light source.

In reply it was pointed out by Purcell[3] and by Hanbury Brown and Twiss[4] that there was no real disagreement between the results of these two tests,

since the experiment of Brannen and Ferguson[2], and the similar experiment of Adám, Jánossy and Varga[5], were far too insensitive to detect the effect. In addition, the reality of the phenomenon has been confirmed by observations[6] on Sirius; also the experiment of Hanbury Brown and Twiss has been repeated under precisely controlled conditions, when the observed correlation, with various degrees of optical superimposition of the photocathodes, agreed within a few per cent with the predictions of theory (unpublished work).

However, to make assurance doubly sure, we have repeated the experiment of Brannen and Ferguson, under conditions which permit the detection of the effect, and have obtained a positive result, in reasonable agreement with theory, as described below.

If a correlation between photons is to be detected in a convenient time by the coincidence counter technique it can be shown, not only that the light source must be brilliant, but also that the light reaching the photocathodes must be confined to a very narrow band. This immediately suggests the use of an isotope lamp and, in the present experiment, the light source was an electrodeless radio-frequency discharge in mercury-198 vapour, cooled by a forced air draught, to which the radio-frequency oscillator delivered 1½ watts of power at a frequency of 800 Mc./s. In other respects the experimental arrangement was very similar to that of Brannen and Ferguson[2], employing 1*P*21 phototubes, the coincidence circuit being that of Bell, Graham and Petch[7], with a resolution time of $3{\cdot}5 \times 10^{-9}$ sec.

The light source was limited by a pinhole 0·360 mm. in diameter; the photocathodes, at a distance of 1·25 metres, were limited by square apertures, 2 mm. × 2 mm., and the 5461 A. line was isolated by an optical filter. Both phototubes were mounted on movable slides so that, as seen by the source, they could be optically superimposed or separated by a distance of 5 mm. transverse to the line of sight; at the latter distance the pinhole source was completely resolved so that the incident light beams were effectively uncorrelated. The photon counts could also be uncorrelated by inserting a length of cable in one channel of the coincidence counter circuit with a delay of 15 mμsec., about four times the resolution time of the coincidence circuit.

The measurements were carried out as follows. The photocathodes were optically superimposed for two minutes and the number of coincidences n_{1r} observed in this interval was recorded. One or other of the photocathodes was then moved to the displaced position, and n_{2r}, the number of coincidences in a two-minute period, was also recorded. This procedure was repeated ten times in a run in which the total observation time was 40 min. and the difference

$$\Delta n_c = \sum_{r=1}^{10} (n_{1r} - n_{2r}) \qquad (1)$$

was measured. In order to eliminate the effect of any difference in the light intensity reaching the two different positions of the photocathode, an identical comparison run was then made with the extra cable inserted in one arm of the coincidence circuit and the difference

$$\Delta n'_c = \sum_{r=1}^{10} (n'_{1r} - n'_{2r}) \qquad (2)$$

between the coincidences observed with the photocathodes superimposed and displaced was recorded. The quantity $N_c = (\Delta n_c - \Delta n'_c)$ was then taken as a measure of the number of correlated photoelectrons emitted in coincidence during a 20-min. interval.

Table 1. Ratio of Correlated to Random Coincidences

Run No.	Observed number of coincidences in 20 min.* (N_T)	Observed number of correlated coincidences in 20 min. (N_c)	Percentage ratio of correlated to total coincidences ($\rho \times 100$)	Ratio of correlated coincidences to r.m.s. uncertainty in random coincidences† $(N_c/2(N_T)^{1/2})$
1	136,941	2,986	2·18	4·03
2	130,067	2,190	1·68	3·04
3	137,435	2,369	1·72	3·2
4	100,782	2,185	2·18	3·43
5	97,258	1,864	1·93	3·0
6	94,739	1,761	1·86	2·8
7	81,576	185	0·22	0·33‡

* The average number of photoelectrons emitted in a 20 min. interval was of the order of 10^9.

† In deriving the root-mean-square uncertainty in the number of random coincidences it was assumed that they obeyed a Poisson distribution. The root-mean-square uncertainty for any one run is twice the square root of the number of coincidences observed in 20 min. since, as explained in the text, each run consisted of four 20 min. observation periods.

‡ Run No. 7 was taken with a broad bandwidth light source, a tungsten filament lamp, for which no significant correlation was expected.

A total of six such tests, with an overall observation time of 480 min., were performed, and the results are shown in Table 1. Combining all the measurements, we conclude that the ratio ρ of the correlated to the random counts is given by

$$\rho_{\text{exp.}} = 0{\cdot}0193 \pm 0{\cdot}0017 \text{ (probable error)} \qquad (3)$$

The probability that this result is a random noise fluctuation is quite negligible, being less than 1 in 10^{15}; in addition, the possibility that it was significantly affected by drifts was eliminated by stabilizing the light intensity and the power supplies to the phototubes, with the result that any such drifts in the counting rate in a 40-min. run were too small, compared with the random fluctuation, to be detected.

A seventh run was then taken with the isotope light source replaced by a tungsten filament lamp, under which conditions no significant correlation is to be expected. As may be seen from Table 1, no significant correlation was in fact observed.

The experimental results have been compared with theory as follows. It has been shown by Purcell[8] that the theoretical ratio ρ of the correlated to the random coincidences is given by

$$\rho_{\text{theor.}} = \frac{\tau_0}{4\tau_c} \qquad (4)$$

in the idealized case of a point source and unpolarized light. In this expression τ_c is the resolving time of the coincidence counter, and $c\tau_0$ is the 'coherence length' of the light when τ_0, which is approximately equal to the reciprocal light bandwidth, is defined by

$$\tau_0 = \int_{-\infty}^{\infty} |\, g^2(t) \,|\, \mathrm{d}t \qquad (5)$$

and $g(t)$, the Fourier transform of $f(\nu - \nu_0)$, the normalized spectral density of the incident light centred on frequency ν_0, is defined by

$$g(t) = \int_{-\infty}^{\infty} f(\nu) \exp(2\pi i \nu t) d\nu \qquad (6)$$

The resolving time τ_c of the coincidence counter was measured to be $3 \cdot 5 \times 10^{-9}$ sec. under the conditions of the present experiment. The value of τ_0 for the mercury isotope lamp was measured by observing the visibility of fringes in a Michelson interferometer as a function of mirror spacing, and was found to be $0 \cdot 73 \times 10^{-9}$ sec.; this is somewhat smaller than the ideal value to be expected from a lamp of this kind with an atomic temperature of $\sim 300°$ K., but the decrease is caused by self-absorption at the centre of the line.

In applying equation (4) to the present equipment it is necessary to reduce the theoretical value of ρ by a factor $\Delta(\nu_0)\gamma$; where $\Delta(\nu_0)$ is the 'partial coherence' factor which allows for the fact that the source is of finite angular size and is therefore partially resolved by the individual photocathodes, and γ takes into account the polarization introduced by the semi-transparent mirror and the false counts due to dark current in the phototubes. The value of $\Delta(\nu_0)$ was calculated to be $0 \cdot 475$, and γ was measured to be $0 \cdot 86$.

With the numerical values given above, the theoretical value for ρ is

$$\rho_{\text{theor.}} = \Delta(\nu_0)\gamma \frac{\tau_0}{4\tau_c} = 0 \cdot 0207 \qquad (7)$$

The error in this value is unlikely to exceed $\pm 0 \cdot 002$ and is principally caused by uncertainties in the value of τ_c, which in turn depends, in a complex manner, upon the amplitude distribution of the pulses from the phototubes.

A comparison of equations (3) and (7) shows that the experimental and theoretical values for the fraction of photoelectrons which are correlated and emitted in time coincidence are in satisfactory agreement, the discrepancy being less than the probable error in the measurement or the uncertainty in the theoretical value. Thus the present experiment confirms the conclusions drawn from the earlier test[1], and shows in a very direct manner that the arrival times of photons at different points are correlated when these points are illuminated by coherent beams of light.

We should like to thank Prof. R. E. Bell for very helpful advice on the operating conditions of the coincidence circuit, and the Division of Electrotechnology of the Commonwealth Scientific and Industrial Research Organization for the use of its high-speed counter. A detailed discussion of this and allied experiments will be submitted for publication in the *Australian Journal of Physics*.

[1] Hanbury Brown, R., and Twiss, R. Q., *Nature*, **177**, 27 (1956).
[2] Brannen, E., and Ferguson, H. I. S., *Nature*, **178**, 481 (1956).
[3] Purcell, E. M., *Nature*, **178**, 1449 (1956).
[4] Hanbury Brown, R., and Twiss, R. Q., *Nature*, **178**, 1447 (1956).
[5] Adám, A., Jánossy, L., and Varga, P., *Acta Hungarica*, **4**, 301 (1955).
[6] Hanbury Brown, R., and Twiss, R. Q., *Nature*, **178**, 1046 (1956).
[7] Bell, R. E., Graham, R. L., and Petch, H. E., *Canad. J. Phys.*, **30**, 35 (1952).

GENE MUTATIONS IN HUMAN HÆMOGLOBIN: THE CHEMICAL DIFFERENCE BETWEEN NORMAL AND SICKLE CELL HÆMOGLOBIN

By Dr. V. M. INGRAM

Medical Research Council Unit for the Study of the Molecular Structure of Biological Systems, Cavendish Laboratory, University of Cambridge

I REPORTED recently[1] that the globins of normal and sickle cell anæmia human hæmoglobins differed only in a small portion of their polypeptide chains. I have now found that out of nearly 300 amino-acids in the two proteins, only one is different; one of the glutamic acid residues of normal hæmoglobin is replaced by a valine residue in sickle cell anæmia hæmoglobin. The latter is an abnormal protein which is inherited in a strictly Mendelian manner; it is now possible to show, for the first time, the effect of a single gene mutation as a change in one amino-acid of the hæmoglobin polypeptide chain for the manufacture of which that gene is responsible.

In previous experiments[1], tryptic digests of the two proteins had been prepared; the resulting mixtures of small peptides were separated on a sheet of paper, using electrophoresis in one direction and partition chromatography in the other. These paper chromatograms derived from the two proteins, which I had called 'finger-prints', showed all peptides to have identical electrophoretic and chromatographic properties, except for one spot, peptide No. 4. This occupied different positions in the 'finger-prints' of normal (Hb *A*) and sickle cell anæmia (Hb *S*) hæmoglobins, indicating that the difference between the two proteins was located there. I have now determined the chemical constitution of these No. 4 peptides derived from both hæmoglobin *A* and *S*.

The hæmoglobin *A* No. 4 peptide was prepared by elution from the neutral fraction of many 'finger-prints', followed by cooled paper electrophoresis in pyridine/acetic acid/water (*p*H 3·6[2]) on Whatman No. 3 *MM* paper at 30 V./cm. for 75 min. The peptide was obtained as a well-separated band and eluted. The hæmoglobin *S* No. 4 peptide could be produced in a fairly pure state by eluting the slowest positively charged band from an extended one-dimensional paper electrophoresis of the peptide mixture in the *p*H 6·4 buffer[1]. In both cases qualitative amino-acid analysis by paper chromatography showed the presence of histidine, valine, leucine, threonine, proline, glutamic acid and lysine. There was more glutamic acid in the hæmoglobin *A* peptide, but more valine in the hæmoglobin *S* peptide. In view of the known specificity of trypsin[3], it was to be expected that these peptides, obtained by tryptic hydrolysis, had lysine at the C-terminal end. This agreed with all the results from the partial acid hydrolysis studies, as reported below.

Partial hydrolysis in 12 *N* hydrochloric acid at 37° C. for two or three days, followed by 'finger-printing'[1], gave the peptides indicated in Fig. 1, and

Fig. 1. Acid degradation and structure of the No. 4 peptides from haemoglobins *A* and *S*. Haemoglobin *A* (full lines): His—Val—Leu—Leu—Thr—Pro—*Glu*—Glu—Lys. Haemoglobin *S* (broken lines): His—Val—Leu—Leu—Thr—Pro—*Val*—Glu—Lys

also free amino-acids, which are omitted from the figure. The N-terminal amino-acids of most of these peptides were determined by the fluoro-2,4-dinitrobenzene method[4]. Together with the amino-acid compositions, these fragments indicated the sequences of the No. 4 peptides of haemoglobins *A* and *S* shown in Fig. 1. The only ambiguity was the amino-acid following threonine. Here the relevant products from the hydrochloric acid splitting—threonyl–prolyl–glutamyl–glutamyl–lysine and threonyl–prolyl–valyl–glutamyl–lysine—were subjected, on paper strips, to a stepwise Edman degradation for two cycles[4,5]. The results indicated the sequence threonyl–prolyl– in both cases. The charge distribution of the two No. 4 peptides shown in Fig. 1 was deduced from the electrophoretic behaviour of the two peptides, especially in relation to the behaviour of the smaller split peptides. The only difference found between the two No. 4 peptides is that the first glutamic acid residue of the haemoglobin *A* peptide is replaced by valine in the haemoglobin *S* peptide.

It is known from X-ray crystallographic[6] and from chemical[7] studies that the human haemoglobin molecule of molecular weight 66,700 is composed of two identical half-molecules, each approximately 33,000. It is believed that this substitution, which occurs in each of the two identical half-molecules, constitutes the only chemical difference between normal and sickle cell anaemia haemoglobins. Certainly the haem groups of the two proteins are the same[8]. The fact that in each half-molecule a glutamic acid is replaced by the neutral amino-acid valine agrees with previous findings that the whole haemoglobin *S* molecule has two to three carboxyl groups fewer than the normal protein[9,10]. All the other peptides of the tryptic digest occupy identical, and characteristic, positions in the two 'finger-prints'. Qualitative amino-acid analyses of these peptides have now been carried out, but have failed to reveal any differences between them. It would seem probable, therefore, that they have identical structures, leaving the two No. 4 peptides as the only ones that differ.

About 30 per cent of the haemoglobin molecule is not susceptible to attack by trypsin and does not appear on the 'finger-print'. To eliminate the possibility that an additional difference resides in these large haemoglobin *A* and *S* fragments, they were digested with chymotrypsin, which attacks them readily. Again two peptide mixtures were obtained, which were examined both by 'finger-printing' and by careful paper chromatography of the neutral peptides. No differences between them could be detected.

We owe to Pauling and his collaborators[9] the realization that sickle cell anaemia is an example of an inherited 'molecular disease' and that it is due to an alteration in the structure of a large protein molecule, an alteration leading to a protein which is by all criteria still a haemoglobin. It is now clear that, per half-molecule of haemoglobin, this change consists in a replacement of only one of nearly 300 amino-acids, namely, glutamic acid, by another, valine—a very small change indeed.

Differences between closely related proteins, involving only a very small number of amino-acids, are known; the clearest examples are the differences between horse, whale, sheep, pig and cattle insulins, which show changes in only one sequence of three amino-acids[11]. However, since these are inter-species differences, the genetic mechanism underlying them is by no means clear and cytoplasmic inheritance has not yet been ruled out. The abnormal human haemoglobins, on the other hand, are a group of very closely related proteins within the same species. It is certain that the inheritance of these proteins is Mendelian in character and occurs through the chromosomal genes. Neel[12] has shown that a single mutational step of such a gene, the one responsible for making haemoglobin, produces the new abnormal sickle cell anaemia haemoglobin. Previous investigations on the normal and the sickle cell anaemia protein could not decide whether the difference between them is due to a difference in folding of identical polypeptide chains or to a difference in the amino-acid sequences of the two chains. While there may also be changes in folding, it has now been definitely established that the amino-acid sequences of the two proteins differ, and differ at only one point. Thus it can be seen that an alteration in a Mendelian gene causes an alteration in the amino-acid sequence of the corresponding polypeptide chain. In the case of sickle cell anaemia haemoglobin, this is the smallest alteration possible—only one amino-acid is affected—reflecting, presumably, a change in a very small portion of the haemoglobin gene. It is not known, but it may well be that this involves a replacement of no more than a single base-pair in the chain of the deoxyribonucleic acid of the gene.

It is well known that mutations lead to very small chemical differences between, for example, flower pigments[13]. It seems likely that these mutations produce first a change in a protein, in this case probably an enzyme, which in turn causes the production of a changed flower pigment. These enzymes, which have not yet been investigated for differences, stand in closer relationship to the gene than do the flower pigments themselves. The protein haemoglobin is just as close. It has therefore been called the first gene product, and is probably the first protein to be made by the gene.

The divisibility of genes in a virus was shown previously in bacteriophage by Benzer[14] and Streisinger[15], who studied the effects of many different mutations of a gene on the behaviour of the virus. Such sub-units in genes have also been shown in *Aspergillus*[16] and *Neurospora*[17]. The results presented in this communication are certainly what one would expect on the basis of the widely accepted hypothesis

of gene action; the sequence of base-pairs along the chain of nucleic acid provides the information which determines the sequence of amino-acids in the polypeptide chain for which the particular gene, or length of nucleic acid, is responsible. A substitution in the nucleic acids leads to a substitution in the polypeptide.

The abnormally low solubility of reduced hæmoglobin *S*, which causes the sickling of the erythrocytes in the anæmia, is presumably a function of the charge distribution on the surface of the molecule. The replacement of two charged glutamic acid residues for two uncharged valines is presumably enough to alter this distribution towards one favouring abnormally easy crystallization.

It is hoped that similar studies of other abnormal human hæmoglobins[18] will provide further insight into the effects of gene mutations.

Full details of this work will be published shortly elsewhere. I am indebted to Drs. S. Brenner and G. Seaman, Cambridge, for supplying blood from patients with homozygous sickle cell anæmia. It is a pleasure to acknowledge the constant interest and encouragement shown by Drs. M. F. Perutz and F. H. C. Crick. Some of the enzymatic digestion and 'finger-prints' were done by Mr. J. A. Hunt; Miss Rita Prior rendered invaluable assistance.

[1] Ingram, V. M., *Nature*, **178**, 792 (1956).
[2] Michl, H., *Monatsh. Chem.*, **82**, 489 (1951).
[3] Sanger, F., and Tuppy, H., *Biochem. J.*, **49**, 463, 481 (1951). Sanger, F., and Thompson, E. O. P., *Biochem. J.*, **53**, 353, 356 (1953).
[4] Fraenkel-Conrat, H., Harris, J. I., and Levy, A. L., "Methods of Biochemical Analysis" **2**, 359 (1955).
[5] Edman, P., *Acta Chem. Scand.*, **4**, 277, 283 (1950).
[6] Perutz, M. F., Liquori, A. M., and Eirich, F., *Nature*, **167**, 929 (1951).
[7] Schroeder, W. A., Rhinesmith, H. S., and Pauling, L. (in the press).
[8] Havinga E., and Itano, H. A., *Proc. U.S. Nat. Acad. Sci.*, **39**, 65 (1953).
[9] Pauling, L., Itano, H. A., Singer, S. J., and Wells, I. C., *Science*, **110**, 543 (1949).
[10] Scheinberg, I. H., Harris, R. S., and Spitzer, J. L., *Proc. U.S. Nat. Acad. Sci.*, **40**, 777 (1954).
[11] Harris, J. I., Sanger, F., and Naughton, M. A., *Arch. Biochem. Biophys.*, **65**, 427 (1956).
[12] Neel, J. V., *Science*, **110**, 64 (1949).
[13] Haldane, J. B. S., "Biochemistry of Genetics" (Allen and Unwin, London, 1954).
[14] Benzer, S., in "The Chemical Basis of Heredity", edit. by McElroy, W. D., and Glass, B., 70 (Johns Hopkins Press, Baltimore, 1957).
[15] Streisinger, G., and Franklin, N. C., *Cold Spring Harbor Symp. Quant. Biol.*, **21**, 103 (1956).
[16] Pritchard, R. H., *Heredity*, **9**, 343 (1955).
[17] Giles, N. H., Partridge, C. W. H., and Nelson, N. J., *Proc. U.S. Nat. Acad. Sci.*, **43**, 305 (1957).
[18] Itano, H. A., *Ann. Rev. Biochem.*, **25**, 331 (1956).

THE REPETITIVE PROPERTY OF THE HUMAN BRAIN AS STUDIED BY THE ELECTROENCEPHALOGRAM AND THE METHOD OF AFTER-IMAGES

By Dr. CATHERINE POPOV

Laboratoire du Conditionnement, Clinique Psychiatrique Infantile du Professeur Heuyer, Salpétrière, Paris

THE study of electrocortical responses to different stimuli has allowed us to establish that a single stimulus of sufficient intensity not only provokes a simultaneous excitation, but also is followed by a series of later excitations which reappear spontaneously, without further stimulation, for several minutes. This phenomenon was called the 'repetitive property of the brain'[1,2].

Using various stimuli in experiments on man, we have likewise observed that a single stimulus evokes in consciousness not one but a set of sensory responses. In fact, a primary response which occurs simultaneously with the stimulus is later reproduced spontaneously a number of times, without further stimulation, thus forming a consecutive after-effect. In the case of stimulation by light, these phenomena are known as after-images; hitherto their appearance had been attributed to a retinal effect. We have proved, however, by conditioning these images, that they may be of central origin and that their spontaneous appearance is a phenomenon inherent in the functioning of the cerebral cortex[3].

The existence of the repetitive property of the brain seems to indicate, from all the evidence, that the sensation experienced is evoked by the simultaneous excitation, that is, the excitation which appears at the very moment of the stimulus. However, it seems probable that the overall sensation experienced is especially evoked by the excitation due to the consecutive after-effect. To elaborate the above phenomena, we have carried out experiments on the electroencephalogram using the following methods.

We selected subjects for study who showed well-defined alpha-waves, and stimuli were given only when alpha-waves appeared on the tracing. The subject is seated alone in a darkened room and receives stimuli controlled by an experimenter in another room which contains all the apparatus, and is separated from the dark room by a third intervening room. He is submitted to light-stimuli the intensity and character of which are kept constant throughout the experiments. Whenever the subject sees an after-image, he registers its appearance by pressing a rubber bulb, which records this event on the electroencephalogram tracing. After each sitting, the subject is asked to draw images in colour as he has seen them during the experiment.

With a normal subject, the light-stimulus evokes a series of after-images characteristic of the cortical response of the subject. Subjects who have been under observation for several years invariably draw the same series of images after each experiment. In some cases, a normal subject may have a consecutive after-effect which does not exceed 90 sec. (in one case, 58 sec.), and shows as few as four or five after-images. With other normal subjects, the number of after-images may exceed several dozen, and the consecutive after-effect may last 20, 30 or more minutes. We have not been so concerned with these latter subjects since the length of the consecutive after-effect does not allow us to give several light-stimuli in a single sitting. With all these subjects, electroencephalogram recordings have shown[3,4] that with the appearance of after-images there is a successive

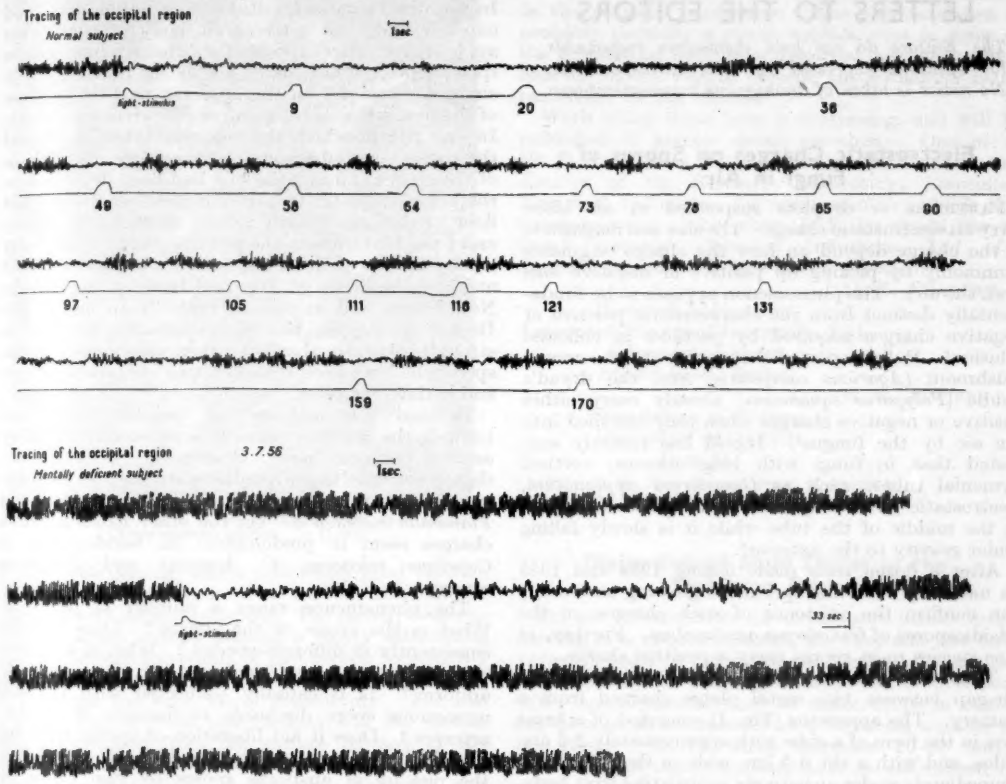


Fig. 1

reduction of alpha-waves, as seen in the tracing (see Fig. 1, upper traces).

In Prof. Heuyer's children's psychiatric clinic, we have used the above methods for studying the response of a number of mental patients. Among these there appeared a group which exhibited absence of after-images in experimental conditions in which a normal subject would see several dozen. In these subjects, the light-stimulus provokes a short after-effect which is manifested by a flattening of the tracings just after the light-stimulus, and lasts at most for 30–35 sec.; the tracing then returns to its original form, without showing the successive reductions well seen in the normal subject (see Fig. 1, lower traces). Thus, we may suppose that these subjects do not see after-images.

In all these cases, the subjects concerned exhibited mental deficiency. The term 'mental deficiency' is understood here in the limited sense of simple intellectual backwardness. Such patients present a number of well-defined characteristics:

(1) Clinically, they show great difficulty in solving a new problem, or in any kind of intellectual achievement; this is seen in the poor scholastic progress of the patient, and also by the slowness with which they acquire in childhood the basic achievements of early development (walking, speech, cleanliness). We have not dealt with subjects showing marked affective problems, or gross disturbance of behaviour.

(2) From the psychological point of view, the intelligence quotient varies between 55 and 80 (Wechsler–Bellevue).

(3) Etiologically, we have not dealt with subjects presenting marked pathological backgrounds (abnormal pregnancy, obstetrical shock, head injuries, previous trauma—infectious or toxic). We have frequently discovered the existence of mental deficiency in the patient's antecedents.

(4) From the point of view of the electroencephalogram, all subjects showed well-defined occipital alpha-waves. We do not suggest that this is an indispensable characteristic in the diagnosis of mental deficiency, but the presence of these well-defined alpha-waves seems to us to characterize a special group of mentally deficient subjects.

Thus, these experiments suggest that the repetitive property of the brain following light-stimulation does not show itself in the mentally deficient studied by me. I am far from wishing to suggest by this that the intelligence of a subject is in direct relation to this phenomenon. I merely think that the repetitive property of the brain is correlated with the degree of ability of the subject to experience the sensation; and clinically this characteristic tracing after light-stimulation has a practical application in that it allows us to distinguish this condition from other mental states.

[1] Popov, Catherine, *C.R. Acad. Sci., Paris*, **241**, 249 (1955); **241**, 535 (1955); *Experientia*, **12**, 7, 274 (1956).
[2] Popov, Catherine, *Ann. Recherche méd.*, 7 (1956).
[3] Popov, N. A., *C.R. Acad. Sci., Paris*, **236**, 744 (1953). Popov, N. A., and Popov, Catherine, *C.R. Acad. Sci., Paris*, **237**, 930 (1953); **237**, 1439 (1953); **238**, 2118 (1954). Popov, Catherine, "On the Mechanism by which Cortical Connections are formed in Human EEG Sound–Light Conditioning" (Paris, October 1955).
[4] Popov, Catherine, *C.R. Acad. Sci., Paris*, **239**, 1859 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electrostatic Charges on Spores of Fungi in Air

Particles or droplets suspended in air often carry an electrostatic charge. The size and magnitude of the charge depend on how the charge originates (commonly by picking up positive or negative ions from the air). The phenomenon appears to be fundamentally distinct from the characteristic positive or negative charges acquired by particles in colloidal solution[1]. Buller reported that spores of the common mushroom (*Agaricus campestris*) and the dryad's saddle (*Polyporus squamosus*) already carry either positive or negative charges when they are shed into the air by the fungus[2]. Ingold has recently suggested that in fungi with long, narrow, vertical hymenial tubes, such as *Ganoderma applanatum*, electrostatic forces may serve to keep a basidiospore in the middle of the tube while it is slowly falling under gravity to the exterior[3].

After a dozen tests made during 1954 and 1955 on naturally occurring specimens growing on trees, I can confirm the existence of such charges on the basidiospores of *Ganoderma applanatum*. Further, in this species most spores carry a positive charge.

Tests were made by allowing spores to fall in an air-gap between two metal plates charged from a battery. The apparatus (Fig. 1) consisted of a brass box in the form of a cube with approximately 2·5 cm. sides, and with a slit 0·5 cm. wide in the lid, placed immediately under an actively sporulating fruit body. The vertical charged metal plates, separated by an air-gap 1 cm. wide, were mounted on 'Perspex' blocks to insulate them from the walls of the box (which was earthed). The circuit was suggested to me in discussion by Mr. H. L. Nixon, of Rothamsted Experimental Station, and consisted of deaf-aid dry batteries giving in series about 400 volts, connected to the vertical plates through 680-kΩ resistors for safety. The poles of the battery were kept at +200 and −200 volts with respect to earth by earthing each end of the battery through 1·0-MΩ resistors.

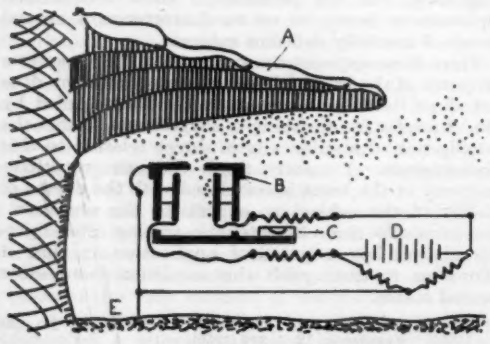


Fig. 1. Diagram (not to scale). *A*, Fruit body of *Ganoderma applanatum* (shown in vertical section) growing on tree trunk and liberating spores into air from vertical tubes; *B*, brass box with slit in lid, connected to earth and holding vertical insulated plates charged to +200 and −200 V.; *C*, bubble level; *D*, battery connected through resistors to plates and to earth; *E*, earth line to ground

In use, the box was levelled with a bubble level and exposed under an active fruit body of *Ganoderma applanatum*. After exposure for an hour, a rusty brown spore deposit was usually visible on the negatively charged plate and on the adjacent part of the base of the box, whereas the positive plate remained clean. In one test in which the box was taken apart and the spores counted under the microscope, 85 per cent of the spores entering the box had been deposited on the negative plate, 14 per cent were on the earthed floor of the box (mostly nearer the negative plate), and 1 per cent were on the positive plate. Essentially similar results with this species have been obtained at three localities in Hertfordshire, at one in the New Forest and at two in Bristol. In one of the Bristol specimens, the spores seemed to be less strongly charged than in other specimens. Some specimens have been tested on two or three occasions and in different years.

Because the majority of basidiospores move towards the negative plate, it is concluded that they carry a positive charge. Preliminary tests indicate that positive charges predominate also on basidiospores of *Agaricus campestris*, *Pholiota squarrosa* and *Flammula carbonaria*. On the other hand, negative charges seem to predominate on basidiospores of *Coprinus micaceus*, *C. hiascens* and *Polyporus squamosus*.

The phenomenon raises a number of problems. What is the origin of the charge? Does it differ consistently in different species? Why, if so nearly uniform in sign, as in *Ganoderma*, is it not completely uniform? Is it causally connected with the still mysterious spore discharge mechanism of basidiomycetes? Does it aid liberation of spores from the fruit body, as suggested by Ingold? Does it affect the pick-up of air-borne spores by rain drops, or their deposition on plant surfaces or in the respiratory tract of vertebrates?

P. H. Gregory

Imperial College of Science and Technology,
London, S.W.7. June 10.

[1] Freundlich, H., "Colloid and Capillary Chemistry", 781 (1926).
[2] Buller, A. H. R., "Researches on Fungi", 1, 192 (1909).
[3] Ingold, C. T., *Endeavour*, **16**, 81 (1957).

Electron Microscopy of Leaf Surfaces

The morphology of leaf surfaces is of considerable interest in the study of the effects of selective herbicides. In the course of investigation into the nature of some leaf surfaces, it was suspected that structure beyond the resolution of the light microscope was present. The electron microscope was therefore employed in an attempt to determine the nature of this structure. The examination of the surface of a leaf required the use of a replica technique, preferably not involving the treatment of the specimen with organic solvents, since many leaf surfaces are covered with a waxy layer which might be affected. A single-stage method involving evaporated material was therefore indicated, and though at first it seemed likely that any such method would meet with considerable difficulties, an extremely interesting technique was easily developed.

The method employs evaporated carbon[1], and is carried out as follows. A portion of the leaf to be examined is fixed to a glass slide with 'Sellotape', and the assembly placed in an evaporating plant. There

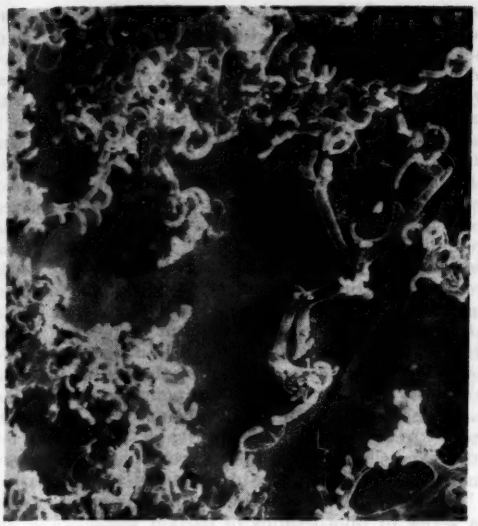


Fig. 1. Carbon replica of the adaxial surface of a leaf of *Chrysanthemum segetum*. × 11,000

is very little gassing, and a sufficiently good vacuum to allow the deposition of a carbon film can be obtained with normal pumping. The carbon evaporation is carried out by passing a heavy alternating current through the points of two carbon rods lightly pressed together. A film between 100 and 200 A. in thickness has been found satisfactory. The leaf is now removed from the vacuum and the carbon film dry-stripped from the surface by any of the normal methods. In many cases it has been found satisfactory to back the carbon with 'Formvar' and then 'Bedacryl', and finally strip the combined films from the leaf with 'Sellotape'. The 'Bedacryl' is dissolved from between the 'Formvar'-carbon film and the tape by immersion in acetone. The 'Formvar'-carbon films can then be mounted on grids and the 'Formvar' washed away with chloroform as described in detail elsewhere[2]. In other cases where the wax layer is excessively thick, it is helpful to freeze the specimen before stripping. The final replica is shadowed before examination in the electron microscope.

It is interesting to note that the leaf does not suffer a gross distortion in its morphology due to the escape of gas in the vacuum plant. The carbon film can be stripped without difficulty, directly from the surface, and this is thought to be due to the wax or cutin acting as a separating layer between the cellulose and the carbon film.

This technique provides, according to the nature of the leaf surface, either a true replica, or a pseudo-replica in which the surface protrusions remain embedded within the carbon film, having been torn off the original surface. Fig. 1 shows the adaxial surface of a leaf of *Chrysanthemum segetum*. There is a large number of branching tube-like structures on the surface, some of which are in the form of spirals, suggesting that they have been extruded. Measurements of contact angle on this leaf gave high values which could not be accounted for by any structure visible in the light microscope. It is thought that the submicroscopic structure found could account for this, especially as a leaf with a low contact angle, *Rumex obtusifolius*, showed a nearly smooth surface in the electron microscope. The replica shown is probably partially a pseudo-replica, that is, some of the protrusions have been dissolved from the carbon film during the replica process, the remainder being embedded in the replica.

Work along these lines is continuing, and will be published in greater detail elsewhere. One of us (D. E. B.) wishes to thank Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, for permission to publish this communication; the other (B. E. J.) would like to thank Imperial Chemical Industries, Ltd., for financial assistance in the above research.

D. E. Bradley

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston Court,
Aldermaston, Berks.

B. E. Juniper

Department of Botany,
University of Oxford.
June 21.

[1] Bradley, D. E., *Brit. J. App. Phys.*, **5**, 65 (1954).
[2] Bradley, D. E., *J. Inst. Metals*, **83**, 35 (1954).

Distortion of Fluid Drops in the Stokesian Region

In an investigation of circulation inside drops moving in a viscous medium, the drop size has been varied in order to determine the factors affecting the minimum size at which circulation can be detected. With some systems, such as water drops in castor oil, circulation commences at a Reynolds number in the range 0·03–0·1 (drop diameter 10–20 mm.), whereas with other systems such as chloroform or carbon tetrachloride in glycerol, circulation begins at much lower Reynolds number of 0·0003–0·001 (drop diameter 1–3 mm.). The interfacial tensions of the two systems are not widely different.

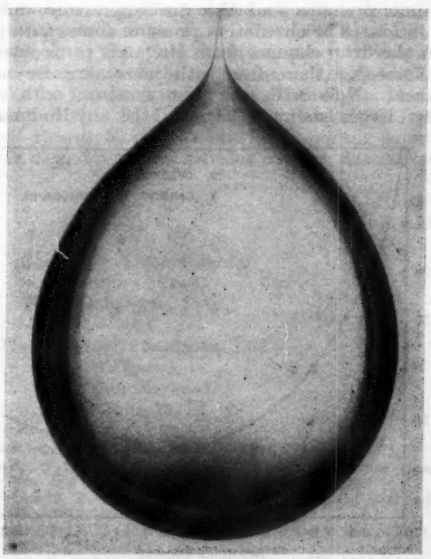


Fig. 1. Water drop falling in castor oil. Dia. = 2·29 cm., fall velocity = 0·87 cm./sec. Re. No. = 0·17

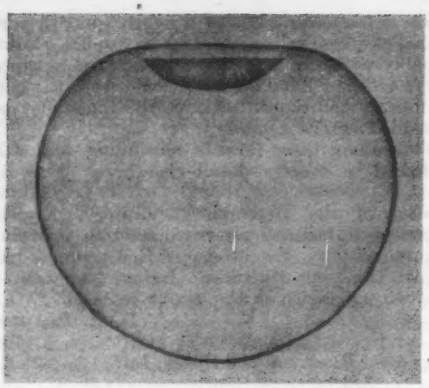


Fig. 2. Chloroform drop falling in glycerine. Dia. = 2·22 cm., fall velocity = 4·36 cm./sec. Re. No. = 0·94

These two types of systems show different forms of drop distortion. For the first type, the drop assumes a 'tailing shape' at the onset of circulation (Fig. 1) and this shape has been observed earlier by Arnold[1]. Savic[2] has suggested that the viscous outward suction at the rear of the drop exceeds the tension in the interfacial layer and causes the surface layer to fold up.

With the second systems, as the size of the drop is increased, the drop remains spherical until the Reynolds number of about 0·1 is reached, when the upper surface of the drop begins to flatten out. For still higher Reynolds numbers, the upper surface folds inward causing an indentation or cavity at the top of the drop. This can be seen clearly in Fig. 2, which is a photograph of a drop of chloroform falling in glycerol. The horizontal line in the cavity is the far top edge of the drop, which is displaced downwards due to optical distortion caused by a slight difference in the refractive indices of the two phases. This form of distortion has not been reported in the past.

The distortion of drops in the Stokesian region depends on the relative changes in the outside hydrodynamic pressure and the inside pressure due to circulation. The circulation pressure comes into play when the drop changes from stagnant to circulating and increases thereafter with increasing Reynolds number. Now with the first systems, with relatively large stagnant drops, the hydrodynamic suction is high, so that a tail is formed before internal circulation is fully developed; this is in accordance with the explanation given by Savic[2]. With the other systems, where circulation begins at very low Reynolds number (less than 0·001) and with much smaller drops, the hydrodynamic suction is very low and there is no distortion. With increasing drop size, the outside hydrodynamic pressure and the inside circulation pressure change in accordance with the Hadamard[3] functions, so that the excess pressure (pressure inside minus pressure outside) remains equal to $2\gamma/a$, where γ is the interfacial tension and a is the local radius of curvature at the rear of the drop. However, at Reynolds numbers greater than about 0·1, the hydrodynamic pressure progressively increases over that indicated by the Hadamard function, and there is a decrease in the excess pressure $2\gamma/a$. Hence a, the radius of curvature at the rear stagnation point, must increase and the drop becomes increasingly flatter at the top. At Reynolds number greater than about 0·4, the excess pressure becomes negative, a assumes a negative value and the drop starts to cave in.

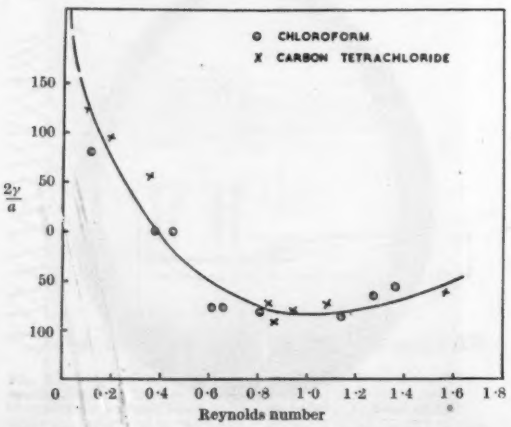


Fig. 3. Reynolds number vs. $2\gamma/a$. Continuous phase, glycerol

To check the validity of the preceding explanation, a series of photographs of carbon tetrachloride and chloroform drops falling through glycerol was taken, and the radius of curvature of the surface at the rear was measured from enlargements of the photographs. The Reynolds number for each drop was plotted against $2\gamma/a$ (Fig. 3). The results in glycerol fall on one curve. The value of $2\gamma/a$ is positive for small Reynolds numbers and decreases with increasing Reynolds number until it reaches zero at Reynolds number 0·4, when the drop begins to cave in; with further increase in Reynolds number, $2\gamma/a$ has a decreasing negative value and beyond Reynolds number 1·0 tends to rise.

A fuller account of this work will be published elsewhere.

F. H. Garner
K. B. Mathur
V. G. Jenson

Department of Chemical Engineering,
University of Birmingham,
Edgbaston,
Birmingham 15. June 25.

[1] Arnold, H. D., *Phil. Mag.*, Ser. 6, **22**, 755 (1911).
[2] Savic, P., "Circulation and Distortion of Liquid Drops Falling through a Viscous Medium", Report, National Research Council of Canada (July 1953).
[3] Hadamard, M. J., *C.R. Acad. Sci., Paris*, **152**, 1735 (1911).

Crystal Structures of Silicon Nitride

Vassiliou and Wilde[1] have recently reported a hexagonal silicon nitride, the X-ray diffraction pattern of which differs from that of the 'orthorhombic' silicon nitride extracted from silicon steels by Leslie, Carroll and Fisher[2]. After preliminary evidence of two different nitrides[3], Turkdogan, Bills and Tippett[4] have now definitely established the existence of two forms of silicon nitride, designated as α and β, with the same chemical compositions (Si_3N_4) and the same measured densities (3·19 ± 0·01 gm./ml.). Even more recently, the same two phases, I and II, as observed by Vassiliou and Wilde have been claimed by Popper and Ruddlesden[5] to be orthorhombic and rhombohedral respectively.

The results of an X-ray examination which we have made on α- and β-specimens prepared by

Table 1. X-RAY DATA FOR SILICON NITRIDES

Present work								Leslie, Carroll and Fisher (ref. 2) (α)		Vassiliou and Wilde (ref. 1) (β)	
α				β							
hkl	$d_{calc.}$	$d_{obs.}$	$I_{obs.}$	*hkl*	$d_{calc.}$	$d_{obs.}$	$I_{obs.}$	$d_{obs.}$	$I_{obs.}$	$d_{obs.}$	$I_{obs.}$
100	6·71	6·65	mw					6·68	vw		
				100	6·59	6·59	m			6·55	m
101	4·31	4·32	s					4·28	s		
110	3·88	3·88	m					3·86	m		
				110	3·79	3·79	m			3·80	m
200	3·35	3·36	mw					3·34	m		
				200	3·29	3·28	ms			3·29	vs
								3·11	vw*		
201	2·88	2·88	s					2·87	s		
002	2·81	2·81	vw					2·80	vw		
				101	2·66	2·66	s	2·65	vw†	2·67	vs
102	2·59	2·59	s					2·58	s		
210	2·54	2·54	ms					2·53	s		
				210	2·49	2·49	s	2·48	w†	2·48	vs
211	2·31	2·31	ms	111	2·31	2·31	mw	2·31	s	2·31	w
112	2·27	2·27	w					2·27	w		
300	2·24	2·24	vw					2·23	w		
				300	2·20	2·19	w				
				201	2·18	2·18	m			2·17	m
202	2·15	2·15	m					2·15	m		
301	2·08	2·08	ms					2·07	s		
220	1·94	1·93	vw					1·93	w		
				220	1·90	1·90	mw				
				211	1·89	1·89	w				
212	1·88	1·88	vw					1·88	w		
310	1·86	1·86	w					1·86	w		
				310	1·83	1·83	mw			1·82	w
103	1·80	1·80	mw					1·80	w		
311	1·77	1·77	mw					1·76	m		
				301	1·75	1·75	ms			1·76	ms

* Impurity. † β Impurity in α.

Turkdogan *et al.* seems to resolve some of the previous anomalies.

α-Si_3N_4 is hexagonal with dimensions: a, 7·748 ± 0·001 A.; c, 5·617 ± 0·001 A.; c/a, 0·7250; V, 292·0 A³. If the unit-cell contents are $Si_{12}N_{16}$, the calculated density (3·184 gm./ml.) is in good agreement with the measured density.

β-Si_3N_4 is also hexagonal with dimensions: a, 7·608 ± 0·001 A.; c, 2·9107 ± 0·0005 A.; c/a, 0·3826; V, 145·9 A³. If the β unit cell contains Si_6N_8, the calculated density (3·187 gm./ml.) and the observed density are again in excellent agreement. These data show that any difference between the chemical compositions of the two forms must be negligible.

Every reflexion observed on 19-cm. powder photographs taken with iron $K\alpha$ X-radiation has been indexed unequivocally. For example, of the forty-eight possible reflexions of the β-Si_3N_4 diffraction pattern, only five are too weak to be observed. As shown by Table 1, which lists only the first few interplanar spacings, the nitride reported by Vassiliou and Wilde is β-Si_3N_4, and the 'orthorhombic' phase found by Leslie *et al.* is undoubtedly α-Si_3N_4 containing small amounts of β and an unknown impurity.

A complete structure determination assigns β-Si_3N_4 to space group $P6_3/m$ with 2N in (*c*) at $\pm(\frac{1}{3}, \frac{2}{3}, \frac{1}{4})$, 6N in (*h*) at $\pm(x, y, \frac{1}{4})$; $\pm(\overline{y}, x-y, \frac{1}{4})$; $\pm(y-x, \overline{x}, \frac{1}{4})$, and with 6Si also in sites (*h*). The atomic parameters $x_N = 0{\cdot}333$, $y_N = 0{\cdot}033$, $x_{Si} = 0{\cdot}172$, and $y_{Si} = -0{\cdot}231$ are probably correct to within ±0·005, since the structure amplitude is sensitive to small atomic movements. The structure is based on the phenacite type[6], Be_2SiO_4, in which the oxygen atoms and the beryllium atoms are replaced respectively by nitrogen and silicon. Each silicon is at the centre of a slightly irregular tetrahedron of nitrogens, and the SiN_4 units are joined by sharing corners in such a way that each nitrogen is common to three tetrahedra. Alternatively, the structure may be considered as an arrangement of eight-membered Si_4N_4 puckered rings joined appropriately. The silicon–nitrogen interatomic distances are 1·72 A. and 1·75 A. Each of the two nitrogen atoms in positions (*c*) is at the centre of an equilateral triangle of silicons, and each nitrogen in (*h*) is displaced by about 0·1 A. from the plane of a less regular triangle of silicon atoms. The covalent bonding is clearly due to the overlap of each of four hybridized sp^3 silicon atomic orbitals with one singly-occupied sp^3 hybrid of a nitrogen atom. The remaining fully occupied p orbital of each nitrogen atom is perpendicular to the three planar sp^3 orbitals and cannot participate in bonding. The structure and the bonding are compatible with the observed high electrical resistivity[5].

The structure of α-Si_3N_4 (space group $P31c$) is a different arrangement of the same tetrahedral units as those which occur in β. Planes of atoms in β are linked along the [001] direction in a sequence *ABAB* . . ., whereas in α the sequence is *ABCDABCD*. . . .

We are indebted to Dr. E. T. Turkdogan, Mrs. P. M. Bills and Miss V. A. Tippett, of the British Iron and Steel Research Association, for providing samples of their α- and β-silicon nitrides and for discussion.

D. HARDIE
K. H. JACK

Chemistry Department,
King's College,
Newcastle upon Tyne,
and
The Thermal Syndicate, Ltd.,
Wallsend,
Northumberland.
June 12.

[1] Vassiliou, B., and Wilde, F. G., *Nature*, **179**, 435 (1957).
[2] Leslie, W. C., Carroll, K. G., and Fisher, R. M., *Trans. Amer. Inst. Min. Eng., J. Metals*, **4**, 205 (1952).
[3] Turkdogan, E. T., and Ignatowicz, S., *J. Iron and Steel Inst.*, **185**, 200 (1957).
[4] Turkdogan, E. T., Bills, P. M., and Tippett, V. A., *J. App. Chem.* (in the press).
[5] Popper, P., and Ruddlesden, S. N., *Nature*, **179**, 1129 (1957).
[6] Bragg, W. L., *Proc. Roy. Soc.*, A, **113**, 642 (1926). Bragg, W. L., and Zachariasen, W. H., *Z. Kristallogr.*, **72**, 518 (1930).

Properties of Palladium–Rhodium Alloys

An earlier communication[1] from these laboratories gave preliminary results of an investigation into the magnetic susceptibilities of a series of palladium–rhodium alloys. A noteworthy finding was that alloying palladium with an element, rhodium, of a much lower susceptibility could, over a limited concentration-range, produce alloys having susceptibilities higher than those of either of the pure metals. This was more noticeable at low temperatures. More detailed investigations, since completed, have confirmed the general correctness of these results although minor adjustments of the absolute values previously given are required in some cases.

In addition to this more extensive investigation covering the magnetic properties of a range of alloys and pure metals, the low-temperature specific heats of four palladium–rhodium alloys have now been measured. The values of γ, the electronic heat coefficient, as obtained from measurements below 4·2° K., are shown as functions of the alloying metal content in Fig. 1. A few results for palladium–silver alloys[2] are also included to indicate the general trend of the curve on alloying with the element of next higher atomic number. For comparison the susceptibility–concentration curves have been drawn for palladium–rhodium and palladium–silver alloys at temperatures of 20·4° and 293° K.

The initial rise in the value of γ above that of pure palladium for small additions of rhodium, followed by the subsequent decrease as the rhodium content increases, is similar to the behaviour shown by the magnetic susceptibility, χ. It would be more illuminating to compare the γ values with the susceptibility values at 0° K.; this would, however, necessitate extrapolating downwards from 20·4° K. In view of the large curvature of some of the susceptibility–temperature curves at low temperatures it has not been considered justifiable to do this.

Although various explanations of the facts here reported are possible it is appropriate in this communication to refer only to the straightforward and consistent qualitative picture provided by the simple band theory, according to which the addition of rhodium creates more holes in the *d*-band while the addition of silver has the contrary effect. This interpretation does not, in its usual form, give a quantitative explanation of the results here presented. In particular, there is difficulty in reconciling the much larger relative increase in susceptibility at low temperatures with the small increase in electronic heat coefficient as small additions of rhodium are made to palladium. Changes in interaction effects with composition may probably be neglected as unlikely to produce considerable differential effects over small composition-ranges. Nevertheless, it is still not to be expected that the curves will be strictly parallel since γ depends essentially on the band height while the susceptibility depends upon both band height and curvature. In view of the gentle curvature of the γ-concentration curve, however, the difference in shape of the two susceptibility–concentration curves is greater than might be anticipated.

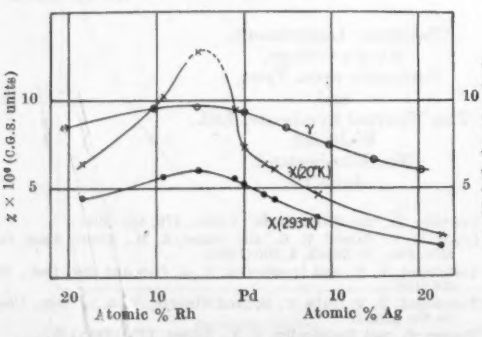


Fig. 1. Mass susceptibility, χ, and electronic heat coefficient, γ, for alloys of palladium with rhodium and silver

F. E. Hoare
J. Preston

Physics Department,
The University,
Leeds 2.

[1] Hoare, F. E., Kouvelites, J. S., and Matthews, J. C., *Nature*, **170**, 537 (1952).
[2] Hoare, F. E., and Yates, B., *Proc. Roy. Soc.*, A, **240**, 42 (1957).

Attractive Forces between Flat Plates

Some years ago investigations were carried out concerning attractive forces between glass and quartz bodies with flat polished surfaces[1]. Due to the well-known hygroscopic behaviour[2] of these surfaces, however, silica-gel obstacles were always present on the plates. These obstacles had a tendency to decrease the attractions and even to turn them into repulsions. Therefore metal plates have now been used instead of glass or quartz. The technique used was similar to that described earlier[1]. The main difficulties were caused by dust particles, and general agreement was found with the conclusions obtained in recent work[3] on the influence of dust particles on the contact of solids. Obstacles (smaller than 10μ) are distributed at random on the plates and show, especially in the case of aluminium plates, some 'compressibility'.

One of the plates could be moved by means of a lever system in a vertical direction towards, or away from, the other plate. This other plate was attached to a spring system. The lever system was checked by capacity measurements and showed a reproducible hysteresis behaviour, the loop-width of the hysteresis curve being 0·20–0·22 micron. This hysteresis behaviour was due to a knife-edge contact in the lever system. Knife-edge contacts, or in general frictional contacts, must therefore be avoided, unless under critical control. Once the properties of the lever system were known accurately, the distance between the metal plates during an experiment was easily calculated, provided the distance at the beginning of an experiment was known. This distance was about 5 microns and was conveniently varied between 2 and, say, 10 microns with an accuracy better than 0·01 micron. The ultimate attractive force K was measured by means of a capacity method.

The measurements, between two chromium plates or between two chromium–steel plates, indicate that Casimir's relation[4] $K = Ad^{-4}$, where d is the distance between the plates and K is the force per unit area of the metal surface, was not contradicted. The constant A was found to be $0{\cdot}01$–$0{\cdot}04 \times 10^{-16}$ dynes cm.^{2}, whereas its theoretical value is $0{\cdot}013 \times 10^{-16}$ dynes cm.^{2}. The uncertainty was due to errors in

the determination of the parallelism of the plates. The distance was varied between 0·3 micron and 2 microns. Surface asperities have so far prevented measurements between aluminium plates.

Pairs of plates of the same metal were chosen, because plates with different surface potentials attract each other according to $K_1 = 4{\cdot}4 \times 10^{-5} P^2 d^{-2}$, where P is the potential difference in millivolts, d is in microns and K_1 is in dynes cm.$^{-2}$. However, the potential difference P is never entirely zero, even if the same metals are used. The two plates were therefore insulated so that the time constant (RC) of discharge of the condenser formed by the two plates was much larger than one second (R being the resistance for charge carriers to come from one surface to the other, C being the capacity of the condenser). This meant that $R \gg 10^9$ ohm.

It may be remarked that already Lucretius[5] seems to have been acquainted with the phenomenon of two plates sticking together. Newton[6] carried out experiments on the adhesion of macroscopic bodies and distinguished between cohesive and gravitational forces.

M. J. Sparnaay

Philips Research Laboratories,
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
April 29.

[1] Overbeek, J. Th. G., and Sparnaay, M. J., *Disc. Farad. Soc.*, **18**, 12 (1954).
[2] See, for example, Kohl, W. H., "Materials Technology for Electron Tubes" (Reinhold, 1951).
[3] Williamson, B. P., Greenwood, J. A., and Harris, J., *Proc. Roy. Soc.*, A, 237, 560 (1956).
[4] Casimir, H. B. G., *Proc. Kon. Ned. Akad. Wetenschap*, **51**, 793 (1948).
[5] Lucretius, "De Rerum Natura", Lib. 1, vs. 385–400.
[6] Newton, I., "Opticks", query 31 (London, 1717); also "Principia", Prop. lxxv, Theorema xxxv, and Prop. lxxvi (London, 1686).

Oxidation of Pentane in Mixtures with Air and the Negative Temperature Coefficient of Reaction

n-Pentane in a chemically correct mixture with air was oxidized in a reactor formed by the annulus between concentric tubes of 'Vycor' (96 per cent silica). The inside diameter of the outer tube was 19 mm. and the outside diameter of the inner was 17 mm. Thus the annulus was 1·0 mm. wide. The reactor was supported concentrically in a vertical tubular electrical furnace 2 in. in diameter. The heated length of the furnace was 6½ in. Temperature as measured on the exterior surface of the reactor attained a maximum value at approximately the mid-section of that length and was taken as related to rate of reaction and to the occurrence of ignition. Air plus the required concentration of pentane was supplied to the reactor at rates ranging from 50 c.c. to 400 c.c./min. Rates of reaction as based on oxygen consumption were determined by Orsat analysis of samples from the reactor effluent. Experimental results for rates of air supply decreasing by steps from 400 c.c. to 100 c.c./min. are given by the graphs of Fig. 1.

When the rate of air supply was 400 c.c./min., reaction did not begin at a measurable rate until the temperature was raised to 650° C. The rates of oxygen reacted and of the products formed as the temperature was further increased are shown by the relevant graphs of Fig. 1. It is to be noted that carbon monoxide was then formed, and at a greater rate than that of carbon dioxide, and that ignition occurred at 747° C. The characteristics of the high-temperature reaction, including the ignition temperature as given by the graphs of Fig. 1, remained substantially unchanged as rates of air supply were decreased to 100 c.c./min. When the rate of air supply was reduced to 200 c.c./min., reaction began at 420° C. and the rate of oxygen reacted increased to a maximum of 0·15 mole per mole of pentane at 470° C. The temperature coefficient then became negative and reaction-rate became zero at 505° C. Reaction did not begin again until the temperature was raised to 650° C., that is, the low- and high-temperature reactions were separated by a temperature interval of 145° C. during which rate of reaction was inappreciable. As rate of air supply was reduced to 150 c.c. and then to 100 c.c./min. the maximum rate of the low-temperature reaction increased while the temperature interval over which there was no appreciable reaction diminished, as shown by the graphs of Fig. 1. The products of the low-temperature reaction were aldehydes, acids, and water. There was no carbon monoxide or dioxide.

The experimental results obtained when the rate of air supply was reduced to 50 c.c./min. are given by the graphs of Fig. 2. It will be seen by a comparison with those of Fig. 1 that reaction began at a lower temperature, coincident with the formation of carbon dioxide, and a few degrees higher with that of carbon monoxide. The low- and high-temperature reactions were not separated by a temperature-range of no reaction. Ignition did not occur, although the temperature was raised to 800° C., the limit of the method of measurement. However, at that temperature 5·75 moles of the 8·0 moles of oxygen in the correct mixture had reacted and the products

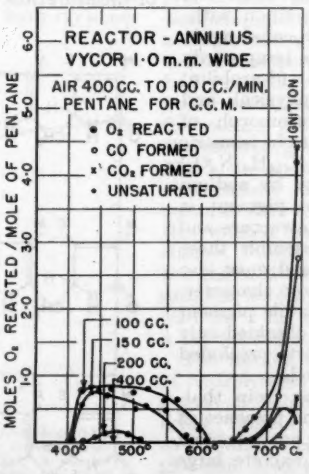


Fig. 1

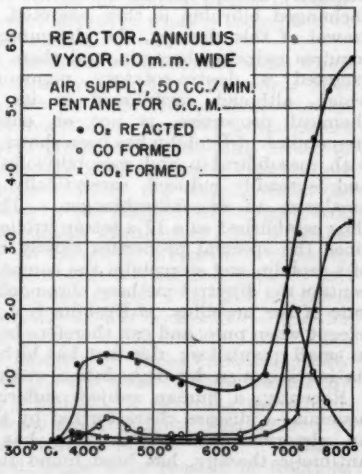


Fig. 2

of the oxidation reaction were carbon dioxide and steam only.

According to Reynolds numbers, the reacting mixture flowing through the reactor comprised a laminar stream with a parabolic velocity profile, bounded by stationary surface layers. Continuance of the oxidation of the surface layers would depend upon the release of the reaction products from the surfaces, their diffusion into the moving stream and diffusion of unreacted mixture from the moving stream to the surfaces. Thus reaction velocity in the low-temperature region in which aldehydes and acids are principal products varies with residence time. It is in this region that a negative temperature coefficient of reaction occurs. The experimental results show it to be a surface phenomenon. It is therefore not necessary to account for it by devising a gas-phase reaction mechanism or by making use of any of those devised by others.

A comprehensive description of the experiments described and of others omitted for the sake of brevity, together with a more complete discussion of the experimental results, will in due course be published in a Canadian journal.

The experiments were carried out in the Department of Chemical Engineering, University of Toronto, with the co-operation of Prof. R. R. McLaughlin, head of the Department and dean of the Faculty of Applied Science, and with the aid of an extra-mural grant from the Defence Research Board, Ottawa.

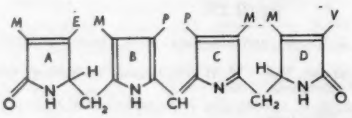
R. O. King
S. Sandler
R. Strom

Department of Chemical Engineering,
University of Toronto,
Toronto, Ontario, Canada.
March 13.

Structure of *d*-Urobilin

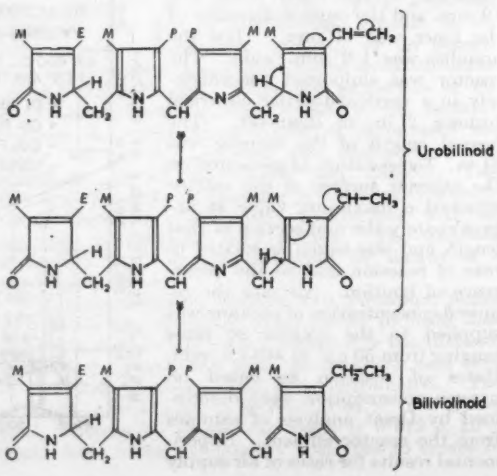
In man the reduction of bilirubin by the intestinal bacteria normally leads to the formation of *i*-urobilinogen and stercobilinogen, which are excreted partly as such and partly as *i*-urobilin and laevorotatory stercobilin respectively. Broad-spectrum antibiotic therapy modifies the intestinal flora and unchanged bilirubin is then excreted. Upon withdrawal of this therapy, the alimentary canal again acquires reducing bacteria, and there is temporarily excreted a dextro-rotatory pigment (*d*-urobilin) which, although urobilinoid in its physical and chemical properties, is not an enantiomorph of stercobilin[1]. *d*-Urobilin has been shown to be isomeric with mesobilirubin and mesobiliviolin ($C_{33}H_{42}N_4O_6$) and is readily reduced, catalytically or by sodium amalgam, to mesobilirubinogen. The pigment is thus established as a IXα tetrapyrrolic structure and since the spectral properties closely resemble those of *i*-urobilin and stercobilin the compound must also contain the dipyrryl-methene chromophore characteristic of the urobilins. *d*-Urobilin is a labile pigment except when pure, and can therefore be obtained only in small quantities; this fact has hitherto precluded its investigation by degradation methods.

Recently, a human subject suffering from thalassæmia—a disease characterized by the presence of an abnormal hæmoglobin—who has not received antibiotic therapy, has been found to excrete large quantities of a pigment ($[\alpha]^D_{\text{chloroform}} = +4{,}520$–$+4{,}700$ for the hydrochloride) which resembles *d*-urobilin in every respect. On oxidation with 0·74 *N* chromic acid, 34 per cent of the nitrogen was converted to ammonia or a labile amine, indicating extensive destruction of the pyrrole rings. Paper chromatography of the other products clearly revealed the presence of hæmatinimide, succinic acid and methylethylmaleimide. The last two substances have been isolated in crystalline form and identified by melting point and mixed melting point determinations. The hæmatinimide would be expected to arise from the β-methyl β′-carboxyethylpyrrole nuclei, the further degradation of which probably accounts for the production of the succinic acid. The occurrence of the methylethylmaleimide proves the presence of a β-methyl-β′-ethylpyrrole ring, but only one such ring can be present in the molecule of *d*-urobilin. The pigment is certainly a dehydro-*i*-urobilin and the additional unsaturation must be located in the β-side-chains rather than elsewhere in the molecule, where its presence would be inconsistent with the presence of the dipyrryl-methene chromophore. Acrylic acid- and ethylidene-groups are, as yet, unknown in the bile pigments, and A. J. Birch, B. R. Smith and G. F. Smith (private communication) have proved the absence of the latter in *d*-urobilin. We therefore suggest the following structure for *d*-urobilin:



where $M = -CH_3$; $P = -CH_2CH_2COOH$; $E = -CH_2CH_3$; $V = -CH{=}CH_2$.

This structure takes into account the ketopyrroline forms known to predominate in the so-called 'hydroxypyrroles'[2] and in the urobilins (Birch *et al.* above) and is one of the two isomers formally possible by interchange of the ethyl- and vinyl-groups. In accordance with this formulation a sample of the hydrochloride ($[\alpha]^D_{\text{chloroform}} = +4{,}700$) in methyl alcohol absorbed a quantity of hydrogen approximately consistent with the presence of two centres of unsaturation.



Both *i*-urobilin and *d*-urobilin are readily dehydrogenated by ferric chloride to give biliviolinoid pigments, but with *d*-urobilin this change can be effected even in a reducing environment (lithium aluminium hydride in tetrahydrofuran). This observation supports the above structure for *d*-urobilin since the conjugated system of double bonds shown in ring *D* would impart considerable tautomeric lability to the hydrogen atom attached to the α-carbon atom, and simple isomerism (involving neither oxidation nor reduction) to a biliviolin is therefore formally possible.

C. H. Gray
D. C. Nicholson

Department of Chemical Pathology,
King's College Hospital Medical School,
London, S.E.5.
April 8.

[1] Lowry, P. T., Ziegler, N. R., and Watson, C. J., Bull. Univ. Minn. Hosp. and Med. Found., **24**, 166 (1952). Watson, C. J., and Lowry, P. T., *J. Biol. Chem.*, **218**, 633 (1956).
[2] Plieninger, H., and Decker, M., *Liebigs Annalen*, **598**, 198 (1956).

Inhibition of Adrenal 11β-Hydroxylation by Ions

Hydroxylation of the 11-position of the steroid nucleus is an essential step in the biosynthesis of the physiologically active adrenal corticoids, cortisol and aldosterone. Previous investigations[1–3] have shown that the reaction is rather involved, requiring the participation of a reducing agent (reduced triphosphopyridine nucleotide), molecular oxygen and several enzymes.

In the present study, the latter were extracted from acetone powders prepared from bovine or porcine adrenal mitochondria, and hydroxylating activity was assayed fluorimetrically, as described earlier[3]. During attempts to fractionate the adrenal extracts with ammonium sulphate and other salts, it was observed that these substances strongly inhibited the 11β-hydroxylation of either 11-deoxycorticosterone or 17-hydroxycorticosterone (compound *S*). Further study indicated that a large series of inorganic ions (sodium sulphate, sodium chloride, potassium chloride, calcium chloride, dipotassium hydrogen phosphate, magnesium chloride, lithium sulphate) was capable of inhibiting the hydroxylation reaction.

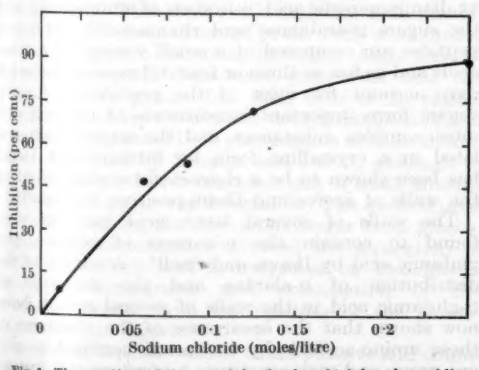


Fig. 1. The reaction mixture contained reduced triphosphopyridine nucleotide, 0·2 μmole; deoxycorticosterone, 0·058 μmole; *tris*(hydroxymethyl)aminomethane buffer, *p*H 7·4, 8 μmoles; enzyme; and added salt as indicated, in a volume of 1·0 ml. 10 min. incubation at 37° C. in air

In Fig. 1, which illustrates this phenomenon when sodium chloride was the inhibitor, it can be seen that inhibition of corticosterone formation from 11-deoxycorticosterone was proportional to the concentration of added salt. A similar inhibitory action of ions has been observed previously with glutamic dehydrogenase[4], and other enzymes.

Although current physiological evidence[5] suggests that intracellular ionic strength is not a primary factor in the regulation of adrenal steroid output, the observation presented here seems of particular interest since the adrenal cortex, by virtue of its ability to synthesize 11-hydroxylated salt-retaining hormones, is, in part, responsible for the maintenance of a constant ionic environment *in vivo*.

Gordon M. Tomkins
Patricia J. Michael

National Institute of Arthritis
and Metabolic Diseases,
National Institutes of Health,
Bethesda, Maryland.
April 12.

[1] Hayano, M., and Dorfman, R. I., *J. Biol. Chem.*, **211**, 227 (1954).
[2] Brownie, A. C., and Grant, J. K., *Biochem. J.*, **62**, 29 (1955).
[3] Tomkins, G. M., Michael, P. J., and Curran, J. F., *Biochim. Biophys. Acta*, **23**, 655 (1957).
[4] Olsen, J. A., and Anfinsen, C. B., *J. Biol. Chem.*, **202**, 841 (1953).
[5] Bartter, F. C., Liddle, G. W., Duncan, jun., L. E., Barber, J. K., and Delea, C., *J. Clin. Invest.*, **35**, 1306 (1956).

Composition of the Cell Wall of *Lactobacillus bifidus*

Analyses of hydrolysates of cell walls from a large number of different Gram-positive bacteria led to the suggestion that the chemical composition of bacterial cell walls may be a valuable taxonomic character. In general, the particular amino-acids present in the cell wall appeared to be characteristic of the genus, while specific and to a lesser extent strain differences were reflected in the type and relative amounts of the sugars and hexosamines present[1].

We have recently examined the cell-wall compositions of eight strains of *Lactobacillus bifidus*. The results are of interest both because they may throw some light on the taxonomic position of *L. bifidus*, and because they reveal an unusual degree of variation among different strains of what is thought to be a single bacterial species.

The strains investigated were some of those which had previously been examined by Hayward, Hale and Bisset[2], and we are indebted to these workers for making them available to us. For examination, the organisms were grown in tomato-juice broth[3] at 37° C., in an atmosphere of hydrogen plus 10 per cent carbon dioxide. After 2–4 days growth the cultures were killed by the addition of formalin, and the washed suspensions disintegrated in a Mickle shaker. Purified cell walls were prepared by digesting the insoluble fraction with trypsin and pepsin[1], and samples were hydrolysed at 100° C. in 2 *N* sulphuric acid for 2 hr. (sugars) or 6 *N* hydrochloric acid for 8 hr. (amino-acids).

The results of analysis by paper chromatography of hydrolysates of the cell walls of these strains are shown in Tables 1 and 2. In recording the amino-acids (Table 1) trace amounts have been ignored to avoid undue complication of the table. Alanine, glutamic acid and lysine were present in fractions from all strains, as were glucosamine and the amino-

Table 1. Amino-Acids

Strain of *Lactobacillus bifidus*	Alanine	Glutamic acid	Lysine	Serine	Glycine	Threonine	Aspartic acid
IR	+++	+++	++	++			
HA	+++	+++	++		++		
BYM	+++	+++	++		++		
PAM	+++	+++	++		++		
BY	+++	+++	++	++		++	
BTR	+++	+++	++	++		++	
HX	+++	+++	++	++			++
CN	+++	+++	++	++			++

Table 2. Sugars and Amino-Sugars

Strain of *Lactobacillus bifidus*	Rhamnose	Galactose	Glucose	Mannose	Glucosamine	Galactosamine	Muramic acid
IR	–	+++	++	*Tr*	+	–	+
HA	++	+++	+++	+	+	–	+
BYM	++	+	+++	*Tr*	+	–	+
PAM	++	++	++	*Tr*	+	–	+
BY	++	*Tr*	++	–	+	–	+
BTR	–	+	*Tr*	–	+	–	+
HX	++	*Tr*	++	*Tr*	+	–	+
CN	++	+	++	*Tr*	+	–	+

sugar which we had previously referred to as 'unknown hexosamine', but which has now been identified by Strange[4] as 3-O-α-carboxyethylhexosamine, for which the name 'muramic acid' has been suggested[5]. Besides these components which were constantly present, however, there were others which showed an interesting degree of variation. Either one or two, but not more, of the amino-acids serine, glycine, threonine and aspartic acid were present in significant quantities. There was also considerable variation in the hexoses present, but rhamnose appeared to be either present in fairly large amount or else virtually absent (Table 2). If we consider only the different combinations of amino-acids, it is possible to distinguish four different patterns of components in the cell walls of these eight strains—a surprisingly high degree of variation in so small a series, and quite unlike anything we have previously encountered. The acid-resistant peptide of lysine and aspartic acid previously noted in cell wall hydrolysates from lactobacilli[1], which is identical with that found in acid hydrolysates of bacitracin[6], was not present in those strains of *L. bifidus* which contain aspartic acid (*HX* and *CN*, Table 1). This suggests that their cell walls are structurally different from those of other lactobacilli in which these amino-acids occur.

The taxonomic position of *L. bifidus* is somewhat uncertain, since it differs considerably in morphology from other lactobacilli, and it has been suggested that it is a corynebacterium, or that it is related to the Actinomycetales. As far as cell-wall composition is concerned, these eight strains do not correspond to any group of Gram-positive organisms previously examined. It seems very unlikely that they belong in *Corynebacterium*, since members of this genus have a cell-wall composition distinguished by the presence of arabinose and α,ε-diaminopimelic acid, neither of which was found in the present strains, and they do not resemble any of the groups so far found in Actinomycetales[7]. On the other hand, it has been reported by several workers[8] that, on repeated subculture, strains of *L. bifidus* become tolerant of oxygen and alter in morphology to a straight rod, resembling other lactobacilli. It seems possible, therefore, that strains of *L. bifidus* are in an unstable state and that the change to 'straight-rod' morphology and oxygen-tolerance might be accompanied by a change in cell-wall structure to that of other lactobacilli, but this point remains to be investigated.

We would like to thank Miss Sylvia Start for considerable technical assistance.

C. S. Cummins
Olivia M. Glendenning
Department of Bacteriology,
H. Harris
Department of Biochemistry,
London Hospital Medical College,
London, E.1. April 8.

[1] Cummins, C. S., and Harris H., *J. Gen. Microbiol.*, **14**, 583 (1956).
[2] Hayward, A. C., Hale, C. M. P., and Bisset, K. A., *J. Gen. Microbiol.*, **13**, 292 (1955).
[3] Briggs, M., *J. Gen. Microbiol.*, **9**, 234 (1953).
[4] Strange, R. E., *Biochem. J.*, **64**, 23*p* (1956). Strange, R. E., and Dark, F. A., *Nature*, **177**, 186 (1956).
[5] Work, E., *Nature*, **179**, 841 (1957).
[6] Swallow, D. L., and Abraham, E. P., *Biochem. J.*, **65**, 39P (1956). Abraham, E. P., and Swallow, D. L. (personal communication) (1957).
[7] Cummins, C. S., and Harris, H., *J. Gen. Microbiol.*, **15**, No. 1, ix (1956).
[8] Norris, R. F., Flanders, T., Tomarelli, R. M., and György, Paul, *J. Bact.*, **60**, 681 (1950). Norris, R. F., de Sipin, M., Zilliken, F. W., Harvey, T. S., and György, Paul, *J. Bact.*, **67**, 159 (1954). Gyllenberg, H. G., *J. Gen. Microbiol.*, **13**, 394 (1955).

Cell-Wall Amino-Acids and Amino-Sugars

Studies of the chemistry of cell walls of many Gram-positive bacteria have established that they possess distinctive properties; indeed, a number of the uncommon constituents of bacterial cells have been found to be localized in the walls, for example, αε-diaminopimelic acid, D-isomers of amino-acids, and the sugars D-arabinose and rhamnose[1–3]. Cell-wall peptides are composed of a small variety of amino-acids and as few as three or four different amino-acids may account for most of the peptide[2,3]. Amino-sugars form important constituents of the cell-wall muco-complex substances, and the amino-sugar isolated in a crystalline form by Strange and Dark[4] has been shown to be a characteristic component of the walls of spores and Gram-positive bacteria[3,4].

The walls of several lactic acid bacteria were found to contain the D-isomers of alanine and glutamic acid by Ikawa and Snell[3]. A survey of the distribution of D-alanine and the detection of D-glutamic acid in the walls of several species have now shown that the occurrence of the D-isomers of these amino-acids is by no means confined to any one group and may constitute a more general feature of cell-wall composition. For qualitative demonstration of D-alanine in bacterial walls, cell-wall hydrolysates (6 *N* hydrochloric acid, 16 hr. at 107° C.)

were subjected to chromatography and the chromatograms sprayed with solutions of D-amino-acid oxidase (sheep kidney cortex); the pyruvic acid formed from the D-alanine was detected with the 2 : 4-dinitrophenylhydrazine spray reagent[5]. Heavy spots corresponding to alanine were obtained, thus indicating the presence of substantial quantities of D-alanine in the cell walls of *Staphylococcus aureus*, *Sporosarcina ureae*, *Sarcina lutea*, *Micrococcus lysodeikticus*, *Bacillus megaterium*, *Bacillus subtilis* and *Clostridium welchii*. Only a weak spot was given with a hydrolysate of *Rhodospirillum rubrum* cell walls. The occurrence of D-glutamic acid in the walls of several of these organisms has been established by separation of the glutamic acid from other cell-wall amino-acids and amino-sugars by paper electrophoresis (Whatman 3*MM* paper, pyridine/acetic acid buffer *p*H 6·4, 220 V. d.c.), colorimetric determination of the total glutamic acid by ninhydrin reaction and estimation of the L-glutamic acid with the decarboxylase method of Gale[6]. Only glutamic acid was detectable in the acidic fractions separable by electrophoresis of hydrolysates of *M. lysodeikticus*, *B. megaterium* and *S. lutea* walls. Apparently all the 6 per cent glutamic acid content of the walls of *M. lysodeikticus* is the D-isomer; as much as 50 mgm. of hydrolysed wall gave no detectable L-glutamic acid when assayed with the decarboxylase. A high proportion of the glutamic acid in *B. megaterium* wall is the D-isomer (total glutamic acid 4·5 per cent, L-glutamic acid 0·5 per cent); the walls of *S. lutea*, on the other hand, contained 4·2 per cent L-glutamic acid.

Diaminopimelic acid isomers present in cell walls have been investigated with the solvent system used by Hoare and Work[7]. The *meso*-isomer was found in the walls of *Escherichia coli* B, *Rhodospirillum rubrum*, *Chlorobium thiosulphatophilum*, *Micrococcus varians* and in a Gram-negative coccus (*LC*) isolated from the rumen of sheep[8]. Walls of *B. megaterium KM* contained mostly *meso*-diaminopimelic acid, but some LL-isomer was also detectable. Only the LL-isomer of this amino-acid was found in the walls of *Cl. welchii*. These results are in complete agreement with those of Hoare and Work[7] on the distribution of the isomers in intact bacteria.

The amino-sugar isolated by Strange and Dark[4] has so far been found in spore peptides and spore walls, the walls of various Gram-positive bacteria[3] and more recently in the nucleotide complexes of *Staphylococcus aureus* studied by Park and Strominger[9]. This amino-acid together with glucosamine has now been detected in the walls of a number of Gram-negative bacteria, including *Esch. coli* B, *Spirillum serpens*, *Salmonella gallinarum* and the Gram-negative coccus, *LC*. Cell walls of the photosynthetic bacteria *Chlorobium thiosulphatophilum* and *R. rubrum* contained both glucosamine and the amino-sugar described by Strange and Dark[4], although in the walls of the latter organism only a small amount of the amino-sugar was detectable. The method used for distinguishing the new amino-sugar from glucosamine or galactosamine involved the separation of 6 *N* hydrochloric acid hydrolysates on two-dimensional chromatograms and examination of the products formed from the reaction of the amino-sugars with ninhydrin[10].

Although the cell walls of Gram-positive and Gram-negative bacteria have a number of amino-acid and amino-sugar constituents in common, the composition of the walls of the Gram-negative organisms shows a greater complexity[1]. This has now been further illustrated by examining the products of the reaction of trypsin-treated walls with 1-fluoro-2 : 4-dinitrobenzene as described by Ingram and Salton[11]. Alanine and glycine were found to be the N-terminal amino-acids common to the cell walls of a number of Gram-negative species, including *Esch. coli* B, *Sp. serpens*, *R. rubrum* and the rumen coccus, *LC*. In addition, some of the walls also possessed aspartic and glutamic acids as N-terminal amino-acids. Whether all these proteins with different N-terminal groups form part of the essential framework of the cell wall or whether they represent proteins of different surface antigens or intracellular components adhering to the walls must await further studies.

M. R. J. SALTON

Department of Bacteriology,
University of Manchester. April 23.

[1] Salton, M. R. J., Sixth Symp. Soc. Gen. Microbiol., 81 (1956).
[2] Cummins, C. S., *Int. Rev. Cytology*, **5**, 25 (1956).
[3] Ikawa, M., and Snell, E. E., *Biochim. Biophys. Acta*, **19**, 576 (1956).
[4] Strange, R. E., and Dark, F. A., *Nature*, **177**, 186 (1956).
[5] Auclair, J. M., and Patton, R. L., *Rev. Can. Biol.*, **9**, 3 (1950).
[6] Gale, E. F., *Biochem. J.*, **39**, 46 (1945).
[7] Hoare, D. S., and Work, E., *Biochem. J.*, **61**, 562 (1955).
[8] Elsden, S. R., Volcani, B. E., Gilchrist, F. M. C., and Lewis, D., *J. Bact.*, **72**, 681 (1956).
[9] Park, J. T., and Strominger, J. L., *Science*, **125**, 99 (1957).
[10] Salton, M. R. J., *Biochim. Biophys. Acta*, **22**, 495 (1956).
[11] Ingram, V. M., and Salton, M. R. J., *Biochim. Biophys. Acta*, **24**, 9 (1957).

Coxo-Subalar Muscle in the Mesothorax of Diptera

Two types of muscle are recognized in the mesothorax of Diptera: first, the large specialized dorsal longitudinal and dorsoventral indirect-flight muscles; secondly, the less specialized muscles that operate the legs and the pleural or so-called direct-wing, or direct-flight, muscles[1–4]. The indirect-flight muscles are described as of a fibrous or fibrillar nature, give a twitch response to stimuli and develop the extremely rapid thoracic vibrations that produce the main flight movements of the wings in Diptera (and Hymenoptera). The second group of less specialized muscles are described as of a tubular nature and give a tetanic response to stimuli; those connected with the wing base are presumed to set the wings and so be responsible for variations in the actual mode of flying.

Partmann[5] directed attention to anatomical peculiarities of the indirect-flight muscles; later, Tiegs[6] showed that the large muscle blocks which Partmann had discussed were giant fibres and not specialized bundles of fibres. Tiegs[6] pointed out that a so-called coxo-subalar muscle running from the meron of the meso-coxa to the subalar sclerite was present in Tipulids, Culicids and Chironomids and absent in such non-nematocerous Diptera as he had examined.

Tiegs[6] and others have assumed that this coxo-subalar muscle was of a nature similar to the other direct-wing muscles associated with the wing-base, namely, of the tubular type.

I have recently been surveying the Diptera generally in respect of the presence or absence of the mesothoracic tergal depressor of the trochanter muscle[7] and have been examining the mesothoracic musculature of *Anisopus* (Anisopidae (= Rhyphidae), Dipt.) in particular. I find that the coxo-subalar muscle is of the fibrillar type and not of the tubular type (Fig. 1), and consists, in *Anisopus*, of two giant fibres.

Fig. 1

Fig. 2

Fig. 1. *Anisopus*. Part of approximately horizontal section of mesothorax with two-fibred coxo-subalar muscle cut transversely. Other indirect (fibrillar) flight muscles and direct (tubular) wing muscles can be seen in approximately transverse section

In both Figs. 1 and 2 *a* is second dorsoventral, indirect-flight, muscle; *b*, oblique, longitudinal, indirect-flight, muscle; *c*, coxo-subalar muscle; *d*, pleural, direct-wing muscles

Fig. 2. *Ptychoptera*. Part of approximately horizontal section of mesothorax with 17-fibred coxo-subalar muscle cut transversely

Examination of some other nematocerous Diptera shows that in their case also the coxo-subalar muscle is of the giant fibre type, the number of fibres being several, if the large indirect-flight muscles are of the multiple type, or few if the indirect-flight muscles, as in *Anisopus*, are of the few-fibre type. Fig. 2 shows the coxo-subalar muscle in *Ptychoptera* (Ptychopteridae (=Liriopedae), Dipt.), in which this muscle is especially large, consisting of some 17 fibres.

This specialized mesothoracic coxo-subalar muscle presumably serves some special function in the flight of these Nematocerous Diptera.

John Smart

Department of Zoology,
University of Cambridge. April 25.

[1] Snodgrass, R. E., "Anatomy and Physiology of the Honeybee" (McGraw-Hill, New York and London, 1925).
[2] Chadwick, L. E., in Roeder, K. D., "Insect Physiology" (Wiley, New York; Chapman and Hall, London, 1953).
[3] Wigglesworth, V. B., "Principles of Insect Physiology" (Methuen, London, 1939).
[4] Pringle, J. W. S., *J. Physiol.*, **108**, 226 (1949).
[5] Partmann, W., *Zool. Jahrb. (Anat. Ontog. Tiere)*, **69**, 507 (1948).
[6] Tiegs, O. W., *Phil. Trans. Roy. Soc. Lond.*, B, **238**, 221 (1955).
[7] Smart, J., Proc./Trans. 10th Cong. Entom., Montreal, 1956 (in the press).

Reinterpretation of some Basal Structures in the Insect Ovipositor

Snodgrass[1] based his interpretation of the female genitalia of the higher insect orders on the condition in Machilidae. In this family the ovipositor on the eighth and ninth segments is derived from the limb bases. The limb bases of the eighth segment (first genital) may be termed the first gonocoxae (1Gx) with the styli, the first gonostyli (1Gs) and the appendages, the first gonapophyses (1Gpo). Similarly, the ninth segment bears the second gonocoxae (2Gx), second gonostyli (2Gs) and second gonapophyses (2Gpo).

In the silver fish (*Lepisma*) and the fire brat (*Thermobia*) (Fig. 1*a*) there is a triangular-shaped sclerite which is fused to the base of the first gonapophysis and articulates with the ninth tergum (T9) and the second gonocoxa. This sclerite is absent as such in Machilidae (*Petrobius*). In *Thermobia* it is not attached to the base of the second gonapophysis as stated by Snodgrass[2]. Since Snodgrass misinterpreted the genitalia of *Thermobia*, he was unable to homologize the condition in that genus with that in the higher insect orders. I find that a more satisfactory interpretation is obtained if the structure in Lepismidae is taken as the archaic type from which the pterygote ovipositor was derived.

In most insect orders the gonostyli are lost in the adult and there is a sclerotic connexion between the base of the first gonapophysis and the ninth tergum. This connexion has been variously interpreted as the first gonocoxa, part of the second gonocoxa or outgrowths of the ninth tergum and the first gonapophysis. It is, in fact, the triangular-shaped sclerite variously modified (Scudder, unpublished work). A study of the abdominal musculature of *Petrobius* and *Lepisma* and the development of the female genitalia in the cricket (*Acheta*) shows that the triangular-shaped sclerite, which I term the gonangulum (Ga), is homologous with the antero-dorsal corner of the limb base of the ninth segment.

In Odonata the archetypal condition is retained in its entirety. The first gonocoxa has previously been termed the basivalvula, and the gonangulum, the valvifer[3]. In Hymenoptera (Fig. 1*b*), the gonangulum, previously interpreted as the first gonocoxa (=first valvifer or triangular plate), retains the triangular shape and attachments. The first gonocoxa is absent in this order. In the orthopteroid orders (Fig. 1*c*), the first gonocoxa and gonangulum fuse to form a composite sclerite. In *Grylloblatta*, however, the two structures remain separate. As in Odonata, in *Grylloblatta* the first gonocoxa has been termed the basivalvula, and the gonangulum, the first gonocoxa[4]. In the hemipteroid orders (Fig. 1*d*), the gonangulum is posteriorly fused to the ninth tergum, but the second gonocoxa still articulates to its ventro-posterior angle.

Ontogenetical studies show that the posterior outgrowths of the second gonocoxae, which develop into what Snodgrass called the third valvulae, are not homologous with the styli of the limb bases of the ninth segment. The term gonostylus, suggested by Michener[5], is therefore inappropriate. The term gonoplac is suggested as a substitute.

Full details of this work, which was carried out while in receipt of a grant from the Department of

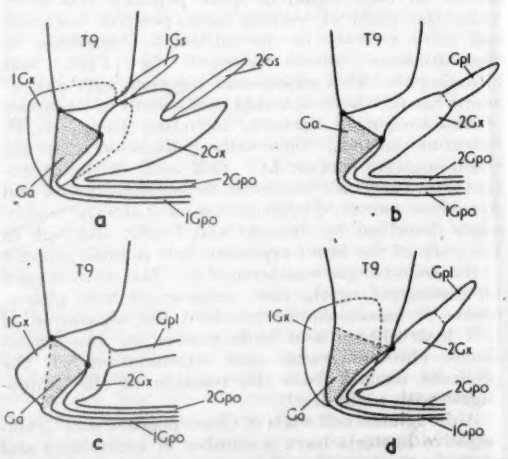


Fig. 1. Inner views of right half of female genitalia (diagrammatic). (*a*) *Thermobia*; (*b*) Hymenopteran, (*c*) Orthopteran, (*d*) Hemipteran

Scientific and Industrial Research, will be published elsewhere.

G. G. E. Scudder

Hope Department of Entomology,
University Museum,
Oxford. March 29.

[1] Snodgrass, R. E., *Smithson. Misc. Coll.*, **89**, Pt. 1 (1933).
[2] Snodgrass, R. E., "Principles of Insect Morphology" (New York and London, 1935).
[3] Asahina, S., "A Morphological Study of a Relic Dragonfly *Epiophlebia superstes* Selys (Odonata, Anisozygoptera)" (Tokyo, 1954).
[4] Walker, E. M., *Ann. Ent. Soc. Amer.*, **36**, 681 (1943).
[5] Michener, C. D., *Ann. Ent. Soc. Amer.*, **37**, 336 (1944).

Development of Beet Eelworm, *Heterodera schachtii* Schmidt, in the Wild Beet, *Beta patellaris*

Observations made by Hijner[1] suggest that, while the roots of the resistant species of wild beet, *Beta patellaris*, are invaded by larvæ of the beet eelworm, *Heterodera schachtii*, no further development occurs beyond an early larval stage.

It has now been found that not only do a large proportion of the larvæ which enter the roots of *B. patellaris* develop to the intermediate or third larval stage, but also that a small percentage develop to maturity, becoming males. This was shown by growing plants singly in 2½-in. pots and adding 2,000 larvæ, hatched from cysts in sugar beet root diffusate, to each pot. The plants were then left for periods of from one to six weeks after the addition of larvæ, there being four plants in each group, making twenty-four plants in all. The roots of each plant were examined for larval stages of the parasite by the usual process of staining in boiling acid–fuchsin, weighing the stained root system and macerating in a domestic blender. The contents of the blender were then washed thoroughly through a 60-mesh sieve and aliquots placed in ringed Petri dishes, when the larvæ were counted under a binocular microscope.

It was found that about 15 per cent of the larvæ added invaded the roots and that, of these, about 65 per cent developed to the intermediate stage and about 7 per cent reached maturity. Even at the end of the six-week period no mature females were found, nor any immature individuals which could with certainty be identified as female. The remaining 35 per cent of the invading second-stage larvæ were either present in a deteriorated condition in the roots or had disappeared. This was also so with the majority of the intermediates.

This state of affairs appears to be a very close parallel to the pattern of development shown by Jones[2] to occur with the potato root eelworm, *Heterodera rostochiensis* Woll., in the wild potato, *Solanum tuberosum* sub sp. *andigena*, where, however, a few females have been found to develop also. It is possible that in further investigations this may also be found to be true of *Beta patellaris*.

I should like to thank Mr. F. G. W. Jones for his advice and also Miss M. Wolfe for technical assistance. I am indebted to the Sugar Beet Research and Education Committee for providing the facilities for carrying out this work.

Audrey M. Shepherd

School of Agriculture,
University of Cambridge. May 30.

[1] Hijner, J. A., *Med. Inst. v. Rat. Suikerproductie*, **21**, 1 (1951).
[2] Jones, F. G. W., *Ann. Appl. Biol.*, **41**, 348 (1954).

Diego Blood Group in Negro

Among the various blood groups employed in anthropology, the Diego is one of the most peculiar to the study of human races.

In Negroes, hitherto the only reference has been the initial paper by Layrisse, Arends and Sisco[1], who found among 150 mixed Negroes that 7·3 per cent had the Diego antigen; but they emphasized the Indian mixture in their stock. We have had the opportunity of testing 120 pure Negro donors of the Instituto de Hematologia da P.D.F., with negative results. The anti-globulin method was employed, with anti-Diego serum, available from Dr. Layrisse.

We believe these results show that the Diego blood group is of capital importance in anthropological research, for the aid it gives in studying the origin, composition and mixture of populations.

We thank Dr. Miguel Layrisse for the supply of the anti-Diego serum.

P. C. Junqueira
P. J. Wishart

Serviço Immuno-hematologia,
Instituto de Hematologia da P.D.F.,
Rio de Janeiro.
May 28.

[1] Layrisse, M., Arends, T., and Sisco, R. D., *Acta Med. Venez.*, **3**, 132 (1955).

Mechanism of Contraction of Smooth Muscle by Drugs

It is generally believed that the process which initiates contraction in striated muscle is the depolarization of the excitable membrane of the muscle fibre, although the mechanism by which membrane excitation is linked with the contractile process is unknown[1]. When smooth muscle is caused to contract by acetylcholine there is a decrease in membrane potential[2], and it would seem reasonable to assume that the sequence of events following action of the drug on the excitable membrane is similar to that postulated for striated muscle, namely, depolarization leading to activation of the contractile element. The following experiments in which the effects of drugs were tested on smooth muscle which had been depolarized by the external administration of potassium ions suggest, however, that activation of the contractile element can be initiated by acetylcholine and other drugs without intervening depolarization.

Isolated preparations of smooth muscle, including the nerve-free amnion of the chick, rat uterus, and separated longitudinal muscle coat of the cat's small intestine, were immersed in Ringer's solution, and their contractions in response to drugs and electrical and mechanical stimulation recorded isotonically. When the sodium chloride of the Ringer's solution is replaced by 'isotonic' potassium chloride (12·3 gm./l.) or potassium sulphate (22 gm./l.) the preparation at first shortens maximally, but soon begins to relax. The degree of relaxation varies in different preparations, but its speed and extent can be increased by lowering the temperature or addition of adrenaline or isoprenaline. These preparations continue to respond to acetylcholine, histamine, 5-hydroxytryptamine and oxytocin when suspended in potassium Ringer. The effect of acetylcholine in potassium Ringer is antagonized by atropine. The

response to electrical stimulation is greatly diminished (much larger stimuli required) in potassium chloride Ringer, and practically abolished in potassium sulphate Ringer. The amnion of the chick which in sodium chloride Ringer responded to a locally applied pinch with a conducted contraction of the whole preparation failed to give this response in potassium chloride Ringer.

Thus it appears that a conducted response of smooth muscle is abolished when the muscle is depolarized as it is abolished in nerve and striated muscle, but contraction in response to drugs, which is presumably due to local excitation of each smooth muscle cell, is preserved. Direct evidence of complete depolarization of the smooth muscle in potassium sulphate Ringer was obtained by intracellular recording, as will be reported elsewhere[3]. A possible explanation of these results is that drugs act directly on the contractile element, but this seems on the whole unlikely, especially with a quaternary ammonium compound such as acetylcholine or a large polypeptide such as oxytocin, which presumably does not diffuse readily into the cell interior. Another possibility is that the action of drugs on the membrane results in the liberation of a chemical agent in the interior of the fibre which activates the contractile element, but there is at present no experimental evidence to support this hypothesis.

D. H. L. Evans
H. O. Schild

Departments of Anatomy and Pharmacology,
University College London,
London, W.C.1.
May 1.

[1] Katz, B., quoted by Hill, A. V., *Proc. Roy. Soc.*, B, **137**, 45 (1950).
[2] Bülbring, E., *J. Physiol.*, **128**, 200 (1955).
[3] Evans, D. H. L., Schild, H. O., and Thesleff, S., *J. Physiol.* (In the press).

Mechanism of Nerve-Impulse Transmission at a Crayfish Synapse

Microelectrodes have been inserted into both pre- and post-junctional elements of certain one-way synapses in the abdominal nerve-cord of the crayfish (*Astacus fluviatilis*). The pre-synaptic fibres are giant axons (lateral and medial) which run through the length of the cord. The post-fibre is, in each case, the largest of the motor axons which leave the ganglion in the third root. Fig. 1 shows an example of nerve-impulse transmission across such a synapse. The pre-junctional axon was stimulated with external electrodes; and its action potential, recorded intracellularly close to the synapse, is shown on the upper trace. The ensuing post-synaptic response, also recorded intracellularly from the junctional region, is shown on the lower beam. The magnitudes of the pre- and post-spikes were 92 and 70 mV., respectively. The post-spike was initiated when the synaptic potential exceeded about 20 mV. In most experiments the preparations were not in as good condition and only a synaptic potential was recorded from the post-fibre. It is difficult to assign a value to the delay between pre-spike and synaptic response. Both potentials seem to arise at about the same time but at different rates. When a test for antidromic transmission is made, it is found that a spike in the post-fibre usually gives rise to no detectable potential change in the pre-axon.

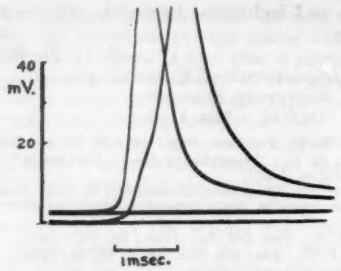


Fig. 1. Transmission of a nerve impulse across the synapse. The pre-fibre had been stimulated by means of external electrodes and the action potentials of pre- and post-fibres recorded each with an intracellular electrode. The pre-synaptic spike is shown on the upper trace, that of the post-fibre on the lower. The magnitudes of pre- and post-spikes were 92 and 70 mV., respectively. The voltage scale is for the post-fibre only. Time calibration, 1 msec.

Concerning the mechanism of the orthodromic transmission, it has been found that even subthreshold electric currents, passed through one of the internal electrodes, can produce appreciable changes in membrane potential, recorded with another electrode, on the opposite side of the synapse. This is quite different from the result which has been obtained at the neuromuscular junction[1]; and it seems very likely that different mechanisms are operating in the two cases. Whereas there is convincing evidence that transmission at the end-plate is 'chemically' mediated[2], there is good reason for believing that at this crayfish synapse the electrotonic currents accompanying the pre-spike cross the junction in sufficient strength to account entirely for the observed synaptic potentials. In addition, the junctional membrane shows marked rectifier properties which would explain the unidirectional nature of the transmission process.

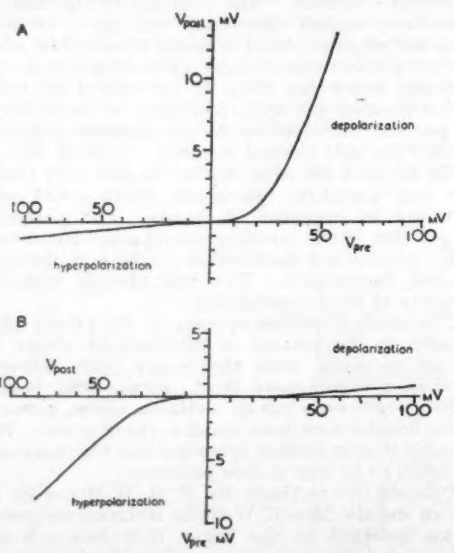


Fig. 2. Transmission of electrotonic pulses across the synapse. *A*, Long pulses of current were passed through one microelectrode in the pre-fibre, while the resulting changes in membrane potential of both fibres were measured. The observed potential changes in the pre-fibre (V_{pre}) are given on the abscissa, while the concomitant changes in the post-fibre (V_{post}) are shown on the ordinate. *B*, Similar results, but in this case the current had been passed through one of the post-fibre electrodes, and V_{post} is now shown on the abscissa

The best evidence for these conclusions comes from experiments with four microelectrodes, in which both a voltage-recording and a current-passing electrode were inserted into each synaptic element. Fig. 2 gives some of the results from such an experiment. The observations shown in *A* were obtained by passing long pulses of current of various known strengths across the pre-fibre membrane, while the concomitant changes in membrane potential of both pre- and post-fibres were measured simultaneously. The magnitudes of the observed potential changes, which had the appearance of electrotonic potentials, are shown on the abscissa and ordinate, respectively. The currents used are not given. It can be seen that depolarizations of the pre-fibre give rise to considerable depolarizations of the post-fibre, while hyperpolarizations have little transjunctional effect. This apparent rectification by the synapse might, of course, be explained by a chemical transmission mechanism, but such an interpretation is made very unlikely by the observations made in the next part of the experiment. In *B*, the resulting potential changes are shown for the opposite situation, in which pulses were passed through the post-fibre current electrode. In this case it is the hyperpolarizations which are transmitted across the junction (antidromically), while depolarizations cross in negligible amounts. The phenomena seen in the two parts of the experiment would be simply explained if the synaptic membrane were a rectifier which passed appreciable positive current only in the orthodromic direction. Depolarizations of the pre-fibre and hyperpolarizations of the post-fibre both give rise to a potential difference across the junctional membrane of the same sign, and would cause current to flow across that membrane in the forward direction. This hypothesis was tested quantitatively by estimating the trans-synaptic currents which would account for the potential changes observed on the other side of the junction (the ordinate values of Fig. 2). It was found, as shown in Fig. 3, that this current (I_{syn}) was the same during a pre-fibre depolarization or a post-fibre hyperpolarization provided only that both gave rise to the same potential difference (V_{syn}) across the junction. Furthermore, the values of I_{syn} seem quite adequate to account for normal transmission of the nerve impulse.

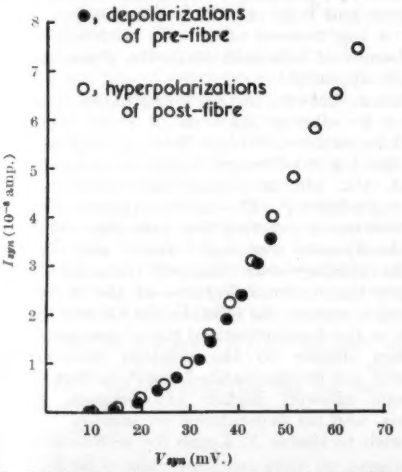


Fig. 3. Relationship between steady-state potential difference across the synaptic membrane (V_{syn}) and the apparent current traversing it (I_{syn}). The changes in V_{syn} were brought about either by passing depolarizing currents through a pre-fibre electrode (filled-in circles) or hyperpolarizing currents through a post-fibre electrode (hollow circles). $V_{syn} = V_{pre} - V_{post}$, depolarizations of pre- or post-fibre being taken as having a positive sign. I_{syn} is the magnitude of the current crossing the synapse which would account for the observed potential changes on the other side of the junction. (The latter potential changes are those given on the ordinates of Fig. 2.) When V_{syn} was negative (that is, with hyperpolarizations of pre-fibre or depolarizations of post-fibre) I_{syn} was very small; but because of the errors involved in estimating these small currents the actual values are not given

There is, then, good evidence that a one-way transmission process can take place by means of an 'electrical' mechanism, namely, one in which the local currents can cross the synaptic membrane in only one direction. This conclusion, however, probably does not apply to some other junctions in the crayfish cord; for there are indications that even this same post-fibre has other synapses on it which rely on a chemical mediator.

E. J. Furshpan*
D. D. Potter†

Biophysics Department,
University College,
London, W.C.1.
April 26.

* U.S. Public Health Service Fellow.
† National Science Foundation Fellow.

[1] del Castillo, J., and Katz, B., *J. Physiol.*, **124**, 586 (1954).
[2] del Castillo, J., and Katz, B., "Progress in Biophysics", **6**, 122 (Pergamon Press, London, 1956).

A Second Oxytocin in the Hypothalamus

Recently[1], we compared oxytocin blood-levels in women during non-pregnancy, pregnancy, labour and lactation under similar conditions of blood collection, extraction and assay, using the sensitized virgin rat uterus. Similar experiments were performed on lactating cows and goats (Hawker, R. W., and Roberts, V. S., unpublished work) and on women who failed to lactate after parturition (Hawker, R. W., unpublished work). The test applied to the extract activity to identify it with oxytocin was its destruction by 0·01 *M* thioglycollate[2]. However, substantial activity frequently remained after thioglycollate treatment; and so it was concluded that another oxytocic substance was often present in blood. Some initial experiments regarding the origin of this have been made.

Extracts of twenty pituitaries, some of the whole gland and some of the posterior lobe only, of cows, oxen, cats (and kittens), rats and mice, were examined after thioglycollate treatment, but none was found to contain significant residual activity. Instead of the longer acid-alcohol method[2] necessary for the extraction of blood a simpler procedure was adopted. Here the tissue after removal was placed in 0·25 per cent acetic acid, immediately boiled for 3 min., ground, left to stand for approximately 30 min., and centrifuged. The supernatant was dialysed and neutralized. Extracts of the hypothalami of cows, oxen, cats (and kittens), rats and mice were next studied and, consistently, residual activities after thioglycollate were obtained. These residual activities ranged from 11 to 75 per cent of the total oxytocic activity of the extracts before thioglycollate with a mean of 35·5 per cent and a standard deviation of 18. Extracts of other parts of the brain and cord similarly treated failed to show residual activity.

This activity was not due to potassium, which had been reduced to negligible amounts by dialysis as verified by flame photometry, nor to acetylcholine

or to hydroxytryptamine as the assay uterus was treated with atropine and dibenamine. Hypothalamic extracts did not prevent the inactivation of added 'Pitocin' (Parke Davis) by thioglycollate. Some properties of the residual activity of hypothalamic extracts after thioglycollate are: (1) it is retained during dialysis by a 'Cellophane' membrane; (2) its dose response curve on the virgin rat uterus is not significantly dissimilar to that of 'Pitocin' (Parke Davis) or to that of the residual activity in blood extracts; (3) it is stable on boiling for short periods; (4) it loses potency if stored at 5° C. for several days (as does 'Pitocin' in dilute solution); (5) it is not recoverable in significant amounts if the hypothalamus is left in the animal for 30 min. after death.

Thus it appears that, in addition to oxytocin, there is in hypothalamic extracts and in some blood extracts a substance which stimulates the sensitized virgin rat uterus treated with atropine and dibenamine, which is non-dialysable and the activity of which is not destroyed by treatment with thioglycollate. We are examining the properties of these substances on other means, for example, milk ejection, guinea pig ileum, to determine whether or not they are identical, and also we are endeavouring to observe whether or not a change in hypothalamic content of this second oxytocin can be correlated with changes in blood-levels of it.

P. A. Robertson

Department of Pharmacology,
University of Sydney.

R. W. Hawker

Department of Physiology,
University of Queensland,
Brisbane.
April 25.

[1] Hawker, R. W., and Robertson, P. A., *J. Clin. Endocrinol. Metab.*, **17**, 448 (1957); *Endocrinol.*, **60**, 652 (1957).
[2] Bisset, G. W., and Walker, J. M., *J. Physiol.*, **126**, 588 (1954).
[3] Van Dyke, H. B., Chow, B. F., Greep, R. O., and Rothen, A., *J. Pharmacol. Exp. Therap.*, **74** 190 (1942).

Alloxan Diabetes in the Piglet

Lukens[1] depancreatized young pigs, and found that the diabetic state which followed was characterized by a slight or absent fasting glucose-excretion, and a low fasting nitrogen-excretion. Ketonuria was marked, but was not accompanied by severe acidosis. These observations are in contrast with those on the depancreatized cat or dog, and the question arises whether a pure beta-cell deficiency diabetes induced by alloxan in the pig is also different from the corresponding condition in other animals. No account of this form of experimental diabetes in the pig has been found in the literature, and this is a preliminary report on the effects of alloxan on the young pig.

The piglets used in these experiments (Landrace × Large White or Large White × Large White) were installed at about two weeks of age in funnel type metabolism cages, equipped for the measurement of food and water intakes and the 24-hourly collection of urine under toluene. The pellet diet used throughout was 'Amvilac No. 2' (Glaxo). Blood samples for glucose estimation[2] were taken from the tail, and urine glucose was estimated by Benedict's quantitative method. Room temperature was maintained at approximately 70° F. Alloxan was injected as a freshly prepared 7–10 per cent solution in 0·9 per cent sodium chloride solution, in animals weighing 5 kgm. or more; the controls received 0·9 per cent sodium chloride solution. All injections were made by the intracardiac route to ensure rapid entry of alloxan into the blood.

Table 1

	Control	Diabetic (maximum values)
Total food eaten in 8 consecutive days (kgm.)	3·55	3·75
Weight gain over same 8 days (kgm.)	2·90	1·50
Urine (ml./24 hr.)	550	7,000
Glycosuria (gm./24 hr.)	0	376
Blood-sugar, feeding (mgm./100 ml.)	80–117	605
Blood-sugar, fasting (mgm./100 ml.)	38–83	303

Fourteen piglets were injected with alloxan in doses ranging from 75 to 250 mgm./kgm. body-weight; of these, six piglets were made glycosuric, including three marked diabetics. No measurable urinary ketosis (that is, more than 1 part per 100,000) was observed at any time. The effective dose of alloxan was 200–250 mgm./kgm. body-weight by intracardiac injection after a fast of 20–24 hr.; if the animal was not fasted it showed marked resistance to the diabetogenic effect of alloxan (cf. ref. 3). The blood-sugar and urinary glucose excretion rose together; the maximum values observed are compared with control values in Table 1 (pigs weighing approximately 8 kgm.).

The alloxan diabetic pig showed a diabetic type of response to the intravenous glucose test (0·5 gm. glucose/kgm.), and the glycosuria and urinary nitrogen were approximately parallel to the food intake. Weight gain continued, although at a reduced rate; the animal was relatively insensitive to insulin.

Differential staining of pig pancreas is difficult; the best procedure found so far includes Zenker-formol fixation and staining by Gomori's chrome-hæmatoxylin phloxine[4], which allows differentiation of alpha and beta cells and acinar tissue. Pancreas from a pig treated effectively with alloxan shows an absence of beta cells while the alpha cells remain readily apparent.

Alloxan diabetes in the young piglet appears to be similar to alloxan diabetes in some other species. The dose, at 200–250 mgm./kgm., is high as compared with the dog (60–75 mgm./kgm.) or mouse (100 mgm./kgm.), but not in comparison with the monkey (300 mgm./kgm.)[5]. The diabetic piglets were followed for three weeks; during that time they did not appear ill, blood-sugar was high, there was no apparent ketosis and they were relatively insensitive to insulin. Despite the unusual features of the depancreatized pig noted earlier, the relation the alloxan diabetic pig bears to the depancreatized pig of comparable weight appears similar to the relation between alloxan diabetic and depancreatized dogs[6], in that the alloxan diabetic showed higher blood-sugars, no severe ketosis, and no dependence on insulin.

I wish to thank A. Legge for technical assistance.

L. E. Mount

Agricultural Research Council
Institute of Animal Physiology,
Babraham, Cambridge. May 2.

[1] Lukens, F. D. W., *Amer. J. Physiol.*, **118**, 321 (1937).
[2] Somogyi, M., *J. Biol. Chem.*, **195**, 19 (1952).
[3] Kass, E. H., and Waisbren, B. A., *Proc. Soc. Exp. Biol.*, **60**, 303 (1945).
[4] Gomori, G., *Amer. J. Path.*, **17**, 395 (1941).
[5] Lukens, F. D. W., *Physiol. Rev.*, **28**, 304 (1948).
[6] Thorogood, E., and Zimmermann, B., *Endocrinology*, **37**, 191 (1945).

Activity and Specificity of Rennin

ALTHOUGH proteolytic activity has been shown by Berridge[1] in a partially crystalline preparation of rennin, and by De Baun, Connors and Sullivan[2] in a preparation 75 per cent pure, there has hitherto been no published proof that the activity is not due to contamination. Moreover, it has been implied that rennin has only weak proteolytic activity[3].

Crystalline rennin has been prepared by the method of Berridge and Woodward[4] from Benger's commercial rennet. Evidence has now been obtained that it is a powerful proteolytic enzyme with a specificity similar to that of pepsin. Proteolytic activity was measured on denatured hæmoglobin by the method of Anson as described by Northrop, Kunitz and Herriott[5], and milk-clotting activity was measured by the technique of Berridge. Throughout the purification, the ratio of these two activities remained constant. This applied even to the later supernatants from salting out with sodium chloride. Recrystallization of rennin has no significant effect on its activity.

	P.A.	*R.*
1st crystallization	0·104	2·33
Mother liquor from 1st crystallization	0·076	2·37
2nd crystallization	0·108	2·42
Mother liquor from 2nd crystallization	0·118	2·44
3rd crystallization	0·113	2·27

P.A.: Proteolytic activity per mgm. of total nitrogen in units exactly as defined in ref. 5.
R: Ratio of milk-clotting activity (in units defined by Berridge) to proteolytic activity.

It can be seen that, measured in this way, rennin has a proteolytic activity similar to that of trypsin and quite comparable with that of the other endopeptidases.

The *B* chain of insulin was considered to be a good substrate for an initial study of the proteolytic specificity of rennin. In most experiments, 1·5 mgm./ml. of the *B* chain was incubated overnight at 30° C. with 0·03 mgm./ml. of twice-crystallized rennin. The digest was then freeze-dried and subjected to ionophoresis on Whatman No. 4 paper at *p*H 6·5. The peptide bands were eluted and the eluates hydrolysed with 20 per cent hydrochloric acid, using the techniques of Sanger and his colleagues[6]. The hydrochloric acid was removed and the constituent amino-acids of the separated peptides were identified by one-dimensional chromatography with phenol/ammonia and also *sec*-butanol/formic acid solvent mixtures. The results indicate that rennin splits the *B* chain of insulin in the following positions:

Phe. Val. Asp. Glu. His. Leu. $CySO_3$. Gly. Ser. His. Leu. ↓ Val. Glu.

Ala. Leu. ↓ Tyr. ↓ Leu. Val. $CySO_3$. Gly. Glu. Arg. Phe. ↓ Phe. ↓

Tyr. Thr. Pro. Lys. Ala.

These are all bonds which are split by pepsin. In contrast to chymotrypsin, which also splits some of these bonds, rennin does not liberate the peptide Thr. Pro. Lys. Ala. from the *B* chain, neither does it act on the chymotrypsin substrate acetyl-tyrosine ethyl ester. However, although the *B* chain digestion by rennin has been repeated several times, no evidence has been found for the breakage of additional bonds which Sanger and his colleagues have found to be split by pepsin. This slightly narrower specificity of rennin is confirmed by comparisons between rennin digests of the *B* chain with pepsin digests. Another difference is that a rennin digestion always leaves equal quantities of the peptides Phe. Tyr. Thr. Pro. Lys. Ala. and Tyr. Thr. Pro. Lys. Ala., whereas pepsin may leave only a trace of the former peptide. Experiments on the progress of the digestion indicate that rennin splits bond 1 more slowly than bonds 2, 3, 4, and 5.

Since pepsin has been shown to be present in commercial rennet, it is important to eliminate any possibility of pepsin contamination interfering with specificity experiments. The presence of 5 per cent of pepsin can be quantitatively detected by electrophoresis. A 0·8 per cent solution of twice-crystallized rennin showed a single symmetrical peak during Tiselius electrophoresis at *p*H 6·5. 5 per cent of crystalline pepsin was added to an identical solution and another electrophoresis was performed. After half an hour a small peak with 5 per cent of the area of the main peak separated. A 4 hr. rennin digest of the *B* chain was then compared with a digest obtained under identical conditions but using a pepsin solution 5 per cent the strength of the rennin solution. Splitting of the *B* chain was considerable in the rennin digest but was negligible in the pepsin digest.

The fact that the action on the *B* chain is not due to pepsin has been further shown by quantitative experiments on the *B* chain using the ninhydrin method of Moore and Stein for following the digestion. Pepsin has an optimum for effect on the *B* chain of about *p*H 2, whereas that of rennin is *p*H 4.

It has been shown chromatographically that rennin at *p*H 6 splits the pepsin substrate carbobenzoxy–glutamyltyrosine. As with pepsin, long incubation periods and high concentrations of enzyme are required.

In conclusion, it must be noted that Holter and Li[7] found that crystalline rennin prepared by Berridge[1] had phosphoamidase activity on the substrate N-(*p*-chlorophenyl)-amidophosphoric acid. Attempts to confirm this on a substrate supplied by Light and Co., Ltd. ('*p*-chloranilidophosphonic acid (Phosphoamidase)'), have failed. Although activity was present in the commercial rennet (measured by the liberation of phosphate as described by Holter and Li), no activity could be detected in crystalline rennin. The substrate gave a high blank. It is suggested that the phosphoamidase activity is due to a contaminant which is not present in crystals prepared by Berridge's latest method.

I am grateful to Dr. F. Sanger for samples of the *B* chain of insulin, to Mr. M. Norton for kindly demonstrating techniques, to Mr. B. Slater for performing the Tiselius electrophoresis, and to Dr. E. C. Webb for advice and encouragement. Full details of this and other work on rennin will be published elsewhere.

J. C. FISH

Department of Biochemistry,
University of Cambridge.
Feb. 11.

[1] Berridge, N. J., *Biochem. J.*, **39**, 179 (1945).
[2] De Baun, R. M., Connors, W. M., and Sullivan, R. A., *Arch. Biochem. and Biophys.*, **43**, 324 (1953).
[3] Nitschmann, H., and Varin, R., *Helv. Chim. Acta*, **34**, 1421 (1951).
[4] Berridge, N. J., and Woodward, C., *Biochem. J.*, **54**, xix (1953).
[5] Northrop, Kunitz, and Herriott, "Crystalline Enzymes" (Columbia Univ. Press, 1948).
[6] Ryle, A. P., Sanger, F., Smith, L. F., and Kitai, Ruth, *Biochem. J.*, **60**, 541 (1955).
[7] Holter and Li, S.-O., *Acta Chem. Scand.*, **4**, 1321 (1950).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GUIDE LECTURER AT THE GEOLOGICAL MUSEUM, London, S.W.7—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting Ref. No. 84739/57 (August 23).

CHEMIST (with an honours degree, A.R.I.C., or equivalent) IN THE RESEARCH LABORATORIES, Leatherhead, Surrey, for work on insulating and lubricating oils and the study of oxidation and anti-oxidation—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. N./346 (August 24).

RESEARCH ASSISTANT (with research experience (academic or industrial) in polymer science) IN THE DEPARTMENT OF CHEMISTRY, to assist in a programme of work on the synthesis of polyethers and a study of their physical properties—The Registrar, The University, Manchester 13 (August 26).

ASSISTANT (with a good degree in anthropology or sociology, and preferably postgraduate experience of field research) IN THE DEPARTMENT OF SOCIAL ANTHROPOLOGY—The Secretary, The University, Edinburgh (August 31).

EXPERIMENTAL OFFICER (with a degree in physics, national certificate in applied physics or equivalent) IN THE PHYSICS DEPARTMENT, to assist on the instrumental side of agricultural meteorology, particularly on the water and energy requirements of growing plants—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (August 31).

LECTURER IN AGRICULTURAL CHEMISTRY—The Bursar, Shuttleworth College, Old Warden Park, Biggleswade, Beds (August 31).

SENIOR LECTURER or LECTURER (graduate in either science or medicine) IN THE DEPARTMENT OF SURGICAL SCIENCE—The Secretary, The University, Edinburgh (September 1).

JUNIOR ASSISTANT PHYSICIST (preferably with previous hospital experience), for duties concerned with routine radiotherapy physics, and the clinical use of radioactive isotopes—The House Governor, Charing Cross Hospital, London, W.C.2 (September 2).

POST-DOCTORAL RESEARCH FELLOW IN CARBOHYDRATE CHEMISTRY—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (September 6).

SCIENTIFIC OFFICER (male, with an honours degree in science) IN THE PLANT DISEASES DIVISION, New Zealand Department of Scientific and Industrial Research, Lincoln, for investigations and identification of diseases of field crops, and testing plant varieties for disease resistance—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. 3/64/187 and mentioning *Nature* (September 6).

LECTURER (graduate, with recognized professional qualifications) IN THE DEPARTMENT OF ENGINEERING, University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 9).

SECOND CHAIR IN AGRICULTURE at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (September 14).

LECTURER IN PHYSICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 20).

RESEARCH FELLOW IN THE DEPARTMENT OF BOTANY, University College, Ibadan, Nigeria, for research into the physiology of host-parasite relationships of Striga—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 23).

STAFF TUTOR (with good qualifications in any branch of the physical sciences) IN PHYSICAL SCIENCE—The Director of Extra-Mural Studies, The University, Edmund Street, Birmingham 3 (September 30).

LECTURERS (2); and a GRADUATE ASSISTANT IN THE COMPUTING UNIT—The Secretary of Faculties, University Registry, Oxford (October 1).

ASSISTANT, Grade B (with a good honours degree), FOR MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham.

ASSISTANT (graduate, with library qualifications and experience) IN THE LIBRARY—The Registrar, The University, Nottingham.

ASSISTANT LECTURER IN THE CHEMICAL PHYSICS OF SOLIDS—Prof. A. R. Ubbelohde, Department of Chemical Engineering, Imperial College, London, S.W.7.

ASSISTANT or ASSOCIATE PROFESSOR (preferably plant biochemist with Ph.D.) IN AGRICULTURAL BIOCHEMISTRY at Ontario Agricultural College—Dr. D. Waghorne, c/o Miss M. A. Ball, 25 Kimberley Road, Cardiff, until September 14, or afterwards to the Department of Chemistry, Ontario Agricultural College, Guelph, Canada.

CHEMIST (young graduate) to assist in a variety of organic preparations connected with researches on biological activity—Dr. C. J. W. Brooks, Clinical Chemotherapeutic Research Unit, Medical Research Council, Western Infirmary, Glasgow, W.1.

CHIEF TECHNICIAN TO SUPERVISE TECHNICAL STAFF IN THE DEPARTMENT OF CHEMISTRY—The Assistant Secretary, Birkbeck College, Malet Street, London, W.C.1.

DEMONSTRATOR (with an honours degree in botany, and at least one year's postgraduate experience in mycology, plant pathology or microbiology) IN HORTICULTURAL SCIENCE, to assist in the laboratory and other practical work in mycology and allied subjects for the (postgraduate) diploma courses in plant pathology and protection and in horticultural science—The Registrar, The University, Bristol.

ENTOMOLOGIST, Assistant Colonial Liaison Officer (with a good honours degree in zoology or entomology, and preferably post-graduate experience, and willing to undertake occasional tours abroad of some months duration)—The Director, Pest Infestation Laboratory, D.S.I.R., London Road, Slough, Bucks.

HOSPITAL BIOCHEMIST with an honours degree, preferably in biochemistry or chemistry), to participate in research into biochemical aspects of fungal diseases of the skin—The Group Secretary, Huddersfield Hospital Management Committee, The Royal Infirmary, Huddersfield.

JUNIOR LECTURER (with an honours degree in chemistry, and preferably previous teaching experience) IN THE DEPARTMENT OF CHEMISTRY—The School Secretary, Middlesex Hospital Medical School, London, W.1.

LABORATORY STEWARD TO TAKE CHARGE OF BOTANY AND ZOOLOGY LABORATORIES at Brighton Technical College—The Director of Education, County Borough of Brighton Education Committee, 54 Old Steine, Brighton.

PHYSICIST (with a degree or equivalent, and experience in crystallography, vacuum technique, X- or gamma-radiography or photography) IN THE RESEARCH LABORATORIES, Leatherhead, Surrey, to work on X-ray diffraction—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. N/347.

RESEARCH ASSISTANTS (2) (chemistry graduates) IN THE DEPARTMENT OF CHEMISTRY, to engage upon original work in one of the following fields of study: (*a*) inorganic chemistry, (*b*) organic chemistry, or (*c*) physical-organic chemistry, with a view to preparing for the Ph.D. degree (London, Internal)—Head of the Department of Chemistry, Chelsea Polytechnic, London, S.W.3.

RESEARCH FELLOW, for work on natural products—The Secretary, The University, Southampton.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1956 to 31st March, 1957. Pp. 40. (London: H.M. Stationery Office, 1957.) 2*s.* 3*d.* net. [117

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the year 1955–1956. Pp. vii+270. (Cmnd. 180.) (London: H.M. Stationery Office, 1957.) 9*s.* net. [117

Three Case Studies in Automation. Pp. vi+58. (London: Political and Economic Planning, 1957.) 7*s.* 6*d.* [117

The Lister Institute of Preventive Medicine. Report of the Governing Body, 1957. Pp. 28. (London: Lister Institute of Preventive Medicine, 1957.) [117

Chelsea Polytechnic. Prospectus, Session 1957–58. Pp. 32. (London: Chelsea Polytechnic, 1957.) [117

Other Countries

Biologische Bundesanstalt für Land- und Forstwirtschaft in Berlin-Dahlem. Bibliographie der Pflanzenschutz-Literatur, 1946–1947. Bearbeitet von Regierungsrat Dr. J. Bärner. (Bibliography of Plant Protection.) Pp. xlii+460. (Berlin-Dahlem: Biologische Bundesanstalt für Land- und Forstwirtschaft, 1957.) 44.50 D.M. [87

Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem. Heft 87: Ergebnisse der 2. Deutschen Arbeitsbesprechung über Fragen der Unkrautbiologie und- bekämpfung am 6/7 Dezember 1956 in Stuttgart-Hohenheim. Zusammengestellt von Prof. Dr. B. Rademacher. Pp. 118. 12 D.M. Heft 88: Viruskrankheiten und ähnliche Erscheinungen bei Obstgewächsen. Von Regierungsrat Dr. K. Schuch. Pp. 96. 8 D.M. (Berlin-Dahlem: Biologische Bundesanstalt für Land- und Forstwirtschaft, 1957.) [87

Colony of Mauritius. Meteorological Observations and Climatological Summaries, 1955. Part 7: July, 1955. Pp. 12. Part 8: August, 1955. Pp. 12. Part 9: September, 1955. Pp. 12. Part 10: October, 1955. Pp. 12. Part 11: November, 1955. Pp. 12. Part 12: December, 1955. Pp. 12. (Port Louis: Government Printer, 1957.) [87

Bulletin of the Royal School of Forestry, Stockholm. No. 23b: Influence of Ownership and Size Structure on Forest Management in Sweden: a Study of Fundamentals. By Thorsten Streyffert. Pp. 44. (Stockholm: Kungl. Skogshögskolan, 1957.) 4 Kr. [87

Department of Agriculture, Ottawa. Report of the Director of Science Service for the year ended March 31, 1956. Pp. 74. (Ottawa: Queen's Printer, 1957.) [87

Research Council of Alberta. Mimeographed Circular No. 22: Bulk Densities, Porosities, and Liquid Saturations of Good Grade Athabasca Oil Sands. By K. A. Clark. Pp. ii+22. (Edmonton, Alberta: Research Council of Alberta, 1957.) [87

World Health Organization. Technical Report Series. No. 126: Prevention of Rheumatic Fever—Second Report of the Expert Committee on Rheumatic Diseases. Pp. 28. (Geneva: World Health Organization; London: H.M. Stationery Office, 1957.) 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars. [87

Bulletin of the Florida State Museum, Biological Sciences. Vol. 2, No. 2: The Subspecies of *Eumeces egregius*, a Lizard of the Southeastern United States. By Edwin H. McConkey. Pp. 13–24. (Gainesville, Fla.: University of Florida, 1957.) 20 cents. [87

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £7/10/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2
Telephone Number: Holborn 4743

All rights reserved. Registered as a newspaper at the General Post Office

From Stock

JENA GLASSWARE

Type G 20—Borosilicate, Highly Acid and Alkali Resisting.

Type D 50—Borosilicate, Chemical and Physical Properties as British Product.

Supremax—High Temperature Resistant, Arsenic-free.

BRAND GLASSWARE

Hexacyl Cylinders, Pipettes, Burettes, etc., with Schellbach and other Indestructible Markings.

ROYAL BERLIN PORCELAIN

Supplied to Order:—

SCIENTIFIC THERMOMETERS

HIGH-TEMPERATURE LABORATORY WARE

REFRACTORY & THERMOCOUPLE TUBING
(Impervious and Porous)

CHEMICALS:—E. MERCK A.-G., DARMSTADT
(Guaranteed Reagents and Laboratory Chemicals)

ANDERMAN & COMPANY LIMITED
Battlebridge House, 87-95 Tooley Street, London, S.E.1 Tel.: HOP 0035/6

IF YOU WANT TO PROJECT

PHOTOGRAPHS
DRAWINGS
MAPS & CHARTS
MANUSCRIPTS
BOOK PAGES
STAMPS & COINS
FABRICS
BUTTERFLIES
MODELS

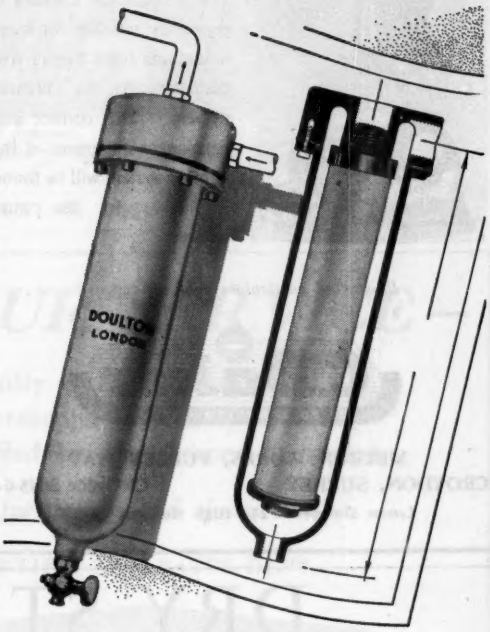
FILM STRIPS & SLIDES

THERE IS ONLY ONE ANSWER

Aldis EPIVISOR Regd.
EPIDIASCOPE

Write for full details to:—
NEVILLE BROWN & CO. LTD. · 77 Newman Street, London, W.1

For compressed air lines . . .



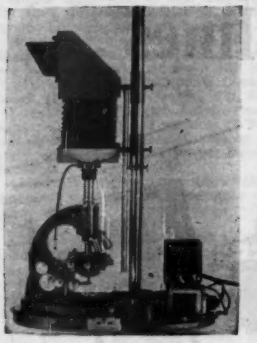
Built specially for heavy duty, this Royal Doulton Filter Unit embodies an outer casing of meehanite and is suitable for use over a wide range of pressures. The filter is normally fitted with a G-6 grade 10″ × 2″ candle, mounted on a perforated tube fitting, since this has been found the most effective for use in compressed air lines. The unit is, however, equally suitable for handling either gases or liquids and can be fitted with any grade of porous ceramic—from less than half a micron to 750 microns, measured maximum pore size. Why not let Royal Doulton advise you upon your filtration problems?

Write for Catalogue No. 10 to:
DOULTON INDUSTRIAL PORCELAINS LIMITED
Dept. C., Royal Doulton Potteries, Wilnecote, Tamworth, Staffs.

Royal **DOULTON**
FILTER UNITS

C D5076

FOR PHOTOMICROGRAPHY



Projectolux Camera

The Projectolux Camera is eminently suitable for magnifications from twenty-five diameters to the highest powers. The correct and permanent alignment of the lighting system will be found invaluable by the busy worker.

Illustrated particulars sent on request

C. Baker
OF HOLBORN LTD. EST. 1765

METRON WORKS, PURLEY WAY
CROYDON, SURREY CROydon 3845-6-7
London Showrooms: 244 High Holborn, W.C.1

BECK
LOW POWER BINOCULAR MICROSCOPES

The many uses in industry and science for which this type of microscope is suited are fully explained in booklet, post free on application.

R. & J. BECK Ltd.
69/71 MORTIMER STREET
LONDON, W.1

DRY STERILIZATION
with the S.223F OVEN

THIS is the Oven used for the experiments on accurate sterilization at 160° C.

It was found that the fan circulation was essential to give reasonably even heating with a big load, and the special fan-cooling device and massive heaters give real reliability under continuous use at this temperature.

Available in grey or white to order

TOWNSON & MERCER LIMITED
CROYDON Telephone: THOrnton Heath 6262 ENGLAND

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and St. Martin's Press, Inc., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, August 17, 1957.